The use of grazing pastures in goat production: development of an approach to combine the optimized use of forage resource and the control of related risks

Martine Napoleone, Herve Hoste, Yves Lefrileux

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The Mediterranean area shows a great diversity of livestock systems, depending on local resources and traditions, but also on the networking space where informational resources are available for producers. During the last decades, a lot of innovations have been conceived or introduced in the Mediterranean area, allowing livestock systems to remain competitive.

The book looks at two main issues: firstly, it gives an updated review on the main innovations that significantly changed the activities of livestock production in the Mediterranean area in the recent past. Secondly, the focus lies on the extent to which these innovations improve the efficiency, ensure the socio-cultural basis or reduce the environmental impact of livestock systems.

One major finding is a new vision of innovating systems based on the distinction between regulated innovation (when aims are fixed) and innovative design (when aims are questioned).

Innovations reported in the book are dealing with a set of concerns. They concern the production techniques, the work organization, the equipment and infrastructures, the collective features for selection, reproduction, feeding or sanitary devices. They also concern the local organization such as product labelling, new dynamics around local breeds, collective rules for supply basin or approaches of new products for new markets. More recently, some innovations focus on environmental impacts of livestock production, due to an increasing consciousness of those kinds of problems.

In the final part of the book, a round table copes with a crucial question: are traditions in Mediterranean livestock activities to be considered an obstacle or a source of innovation?

This book provides a set of updated information and knowledge useful for researchers, students, extension services and policy-makers in the field of animal science.

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M. Napoléone[1], H. Hoste[2] and Y. Lefrileux[3]
[1]*INRA, SAD Ecodeveloppement, Domaine St Paul, Agroparc, 84914 Avignon cedex 9, France*
[2]*INRA, UMR 1125, INRA ENVT, IHAP, 23 chemin des capelles, 31076 Toulouse cedex, France*
[3]*PEP Rhône Alpes, Le Pradel, 07170 Mirabel, France*

Abstract

This article describes an approach to provide support for changes in herd management to increase the proportion of grazed forage in the diet of dairy goats. This research was conducted in collaboration with researchers, agricultural advisors and farmers. The use of grazed forage introduces many sources of uncertainty for the farmers (fluctuating resource, risks of drought or parasite infestations). It is thus difficult to propose a robust technical model that is reliable in a variety of circumstances. The aim of the approach described here is to make the progressive adaptation of herd management feasible. The approach is based on the formalisation of the farmer's practices in time and in space, and makes it possible to analyse combinations of the different grazed resources in relation to indoor feeding, production management and the epidemiology of gastrointestinal nematodes, used as a model of parasite infections. These representations help diagnose the system, identify the possibilities of adaptation and discuss corrective actions. In supporting and guiding such innovative processes, researchers and agricultural advisors have to modify the angle from which they observe the situation. The tool was initially developed from data acquired in Mediterranean conditions. However, it could be of interest for other production systems and/or in other regions, in particular for farmers who currently use intensive systems and who have lost the know-how required for managing a grazing herd, but who are concerned by a return to less intensive management systems in order to fulfil the criteria of sustainable development.

Keywords: goat production, herd management, grazed resources

Introduction

In goat farming, the development of grazing is a major issue, whether from the viewpoint of returning to less intensive practices, reducing farming costs, organising work, or making best use of links with the 'terroir'. However, the use of grazing is accompanied by risks related to the evolution of the grazed resource or increased exposure to risks of parasite, among others.

Developing grassland obliges livestock farmers to manage their herd in situations of uncertainty, requiring them to move from a logic where the objective is to control the principal parameters of herd management (calculating the ration to adjust feed inputs to the needs of the animals or managing health hazards such as parasite infestation), to a posture in which they come to terms with risks by seeking balances. Until recently, grazing had become marginal in the major dairy goat areas in France, but back in the 1970s it was one of the driving forces for neo-rural people setting up pastoral goat-farming systems in areas with woods and rough grazing in Mediterranean regions. By using grazing land, Mediterranean goat farmers developed alternative management methods to the technical models that dominated goat farming at that time. To compensate for their relative lack of control over each resource, the farmers combined a range of spontaneous and cultivated resources, whether daily, or at the level of the whole grazing period.

In this context, for about 15 years, work has been underway in close cooperation between researchers, agrocultural advisors and farmers, with the aim of developing approaches to strengthen farmers' abilities to manage herds using a range of different grazing land. This work relies on the study of farmers' practices, and is based on the identification of keys for interpreting and analysing the situation.

Taking the above work as our basis and using a concrete example, here we present an approach for planning the use of grazing land, estimating the risks associated with the management of milk production and the risks of parasite infection. The approach is based on the co-construction of graphs depicting herd management to facilitate analysis of the existing situation, and to help in the diagnosis and search for corrective scenarios.

In the first section, we present the general principle of the approach. In the second section, we stress the need for technical diagnoses to optimize the use of resources using two different angles of analysis: the management of dairy production and the consideration of health hazards, taking as a model infestation by digestive tract strongyles. In the third section, we discuss the role of the intermediate object and the indicators, to help elaborate a shared diagnosis process.

Methods

Characterising the technical management of a grazing herd

In the South of France, a great deal of research and development has focused on understanding how pastoral farms function so as to be able to work out situation diagnoses. They study the way in which the process for developing productions is organised over time. To understand the organisation set up by the farmers, and to make this analysis easier, some authors have recommended the adoption of calendars to represent practices (Landais and Balent, 1993). Thus, Bellon *et al.* (1999) developed grazing calendars to study the use of the different fields of the farm. These representations, carried out at the scale of the farming production year, make it possible to characterise the farmer's management entities and the way in which he combines and prioritises his practices. These authors then interpret the coherence underlying this organisation. So these representations make it possible to connect a practice carried out at a given moment (such and such a field used in rotation) to the overall organisation over the farming year (the role of a given field in the grazing calendar). Several studies have focused on grazing strategies (Bellon *et al.,* 1999), feed strategies (Hubert *et al.,* 1993), or production strategies (Napoléone, 1999).

The livestock diagnosis: a question of viewpoint and angle of analysis

Characterising herd management over time makes it possible to identify the strengths and weaknesses, and ways to improve the situation. However, the same situation can give rise to different diagnoses and lead to quite different courses of action depending on whether it is evaluated from a technical or a practical point of view (Darré, 1999).

Technical diagnoses and their angles of observation

A diagnosis can be made from a technical point of view, from references and indicators measuring a difference between a standard or a model and what is actually carried out, or estimating a risk, taking into account what is known about the subject. Observing a situation, technicians[13] note a number of parameters on which to base their opinion and make their evaluation. Of course, the parameters will vary with the question asked. For example, a grazing calendar can be analysed to optimise plant production. In this case, the focus will be on the number of days the herd spent grazing the fields concerned to estimate production, which can then be compared with regional references. The same calendar can be analysed from the point of view of managing the milk production of the grazing

[13] Technician: someone with technical knowledge such as an extension agent or a scientist.

herd. In this case, the focus will be on how the unfolding of the calendar is linked to production. On the other hand, if the question is how to control parasite infestation, the parameters will seek to estimate the risks associated with the use of the grazing land. A technical diagnosis can be formulated at several levels. It is directly related to how the question is formulated at the outset, which itself determines the technical indicators chosen for the analysis.

The diagnosis of the one carrying out the practices expresses implicit and varied factors

The farmer's diagnosis is made from the point of view of the person carrying out the practices. He evaluates the situation, taking into account his production target, his constraints, the way he organises his work, his way of perceiving risks… In other words, it is a set of implicit or explicit factors that contribute to his assessment of the situation.

Making a shared diagnosis to plan the use of grazing land by managing the associated risks

A diagnosis of the existing situation that is shared by a technician and a farmer is difficult since it involves constructing a judgement from two points of view of the same situation (Darré *et al.*, 2004). To get round this difficulty, the grassroots approach we present is based on four steps undertaken in collaboration with the farmer:

- *Represent the practices on graphs:* in collaboration with the farmer, a chart is created to be used as a basis for dialogue between the technician and the farmer.
- Analyse the chart to understand – and formalize – *the method of organisation and the underlying logic*
- *Establish a diagnosis,* identify the key points and the problems, estimate risks, etc. from both points of view
- *Imagine ways to act, to test a new method of organisation to reduce the risks* (e.g reorganisation of grazing) *that is compatible with the operation of the farm.*

This diagnostic approach, carried out in year N, is based on a comprehensive interview lasting approximately two hours. Initially the farmer describes how his practices unfold. A calendar is used to represent this process visually. In the second part of the interview, the calendar helps analyse the situation and making a combined diagnosis. In year N+1, the same approach can be used again to make a new assessment, to learn from the corrections undertaken, or to readjust the system according to the objectives.

Here we describe the aid to diagnosis on the use of grazing land using a concrete example, 'M' (Box 1), based on participatory research concerning the technical management of a grazing herd (Institut de l'Elevage, 2007) and associated risks (PEP, 2007). We first describe the steps that characterise the use of grazing land and herd management. We then tackle the question of the diagnosis, developing two successive points of view: (1) analysis of the production calendar from the viewpoint of herd production management; (2) analysis of the calendar from the viewpoint of gastro-intestinal infestation by strongles (SGI). We show the interest of managing the two assessments together to identify prospects for organisation taking these two aspects into account.

Box 1. Use of grazing land.
'M': a goat farmer who produces organic cheese in the *Drôme Provençale*, France.
Herd: 70 Alpine goats.
Production: 720 l/year/goat and 50,000 l/year for the herd.
Territory: 18 ha of fields that can be mowed, 35 ha of woods and heath.
Cheese processing on the farm and direct sale of Picodon AOC.

Understanding herd management and the use of grazing land

Representing the grazing calendar and herd management

The first thing to be understood is the way in which the farmer structures and divides up his territory. Thus in the example in Figure 1, the farmer creates units of use, to which he gives precise names. These units of use are defined by the way the farmer uses them. They are not necessarily based on agronomic properties or cadastral plots. Their periods of use can be marked on a grazing calendar.

Based on the calendar, grazing can be linked to management practices (reproduction, feed, pathology, grazing etc.), or to the evolution of herd production. In this way, a factual representation is obtained of how herd management unfolds (Figure 2).

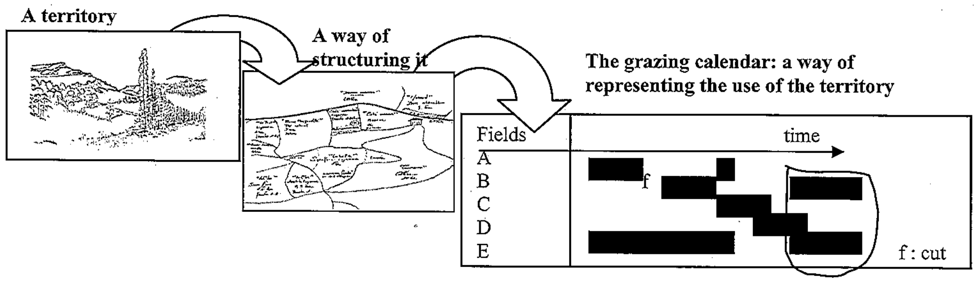

Figure 1. From the description of the territory to the grazing calendar.

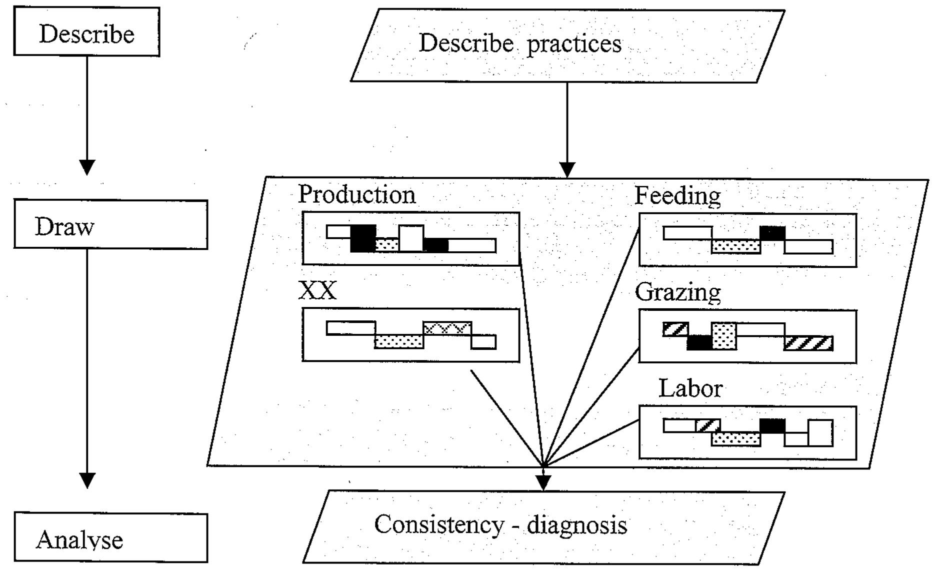

Figure 2. A factual representation of herd management.

Characterising the organisation of grazing in relation to herd management

The calendar makes it possible to analyse the combinations and successions of practices and then to formalise herd management. So, to take our example again (Figure 3), Box 2 formalises the progress of herd management and grassland management set up by 'M'.

Diagnosing the use of grazing

From the viewpoint of herd production

During grazing, herd production can vary to a greater or lesser extent. An abrupt change in the quality or quantity of grazing results in a marked change in production. The analysis of the temporal agreements between management sequences and production management makes it possible to diagnose the links between practices and production and plan courses of action with the farmer. In the example used, (Figure 2) the diagnosis carried out in year N highlighted the fact that difficulties in maintaining production in spring are directly related to the management of grazing land (exhaustion of the resource of sainfoin used since the herd was put out to grass, continuous grazing of an large area, no more grazing on forage at the end of May). Three courses of action are studied: re-examine the balance between cutting/grazing and assign an additional field for spring grazing, subdivide and organise rotations in the natural grasslands and heathlands, grow a vetch/oats mixture specifically for the transition period at the end of spring.

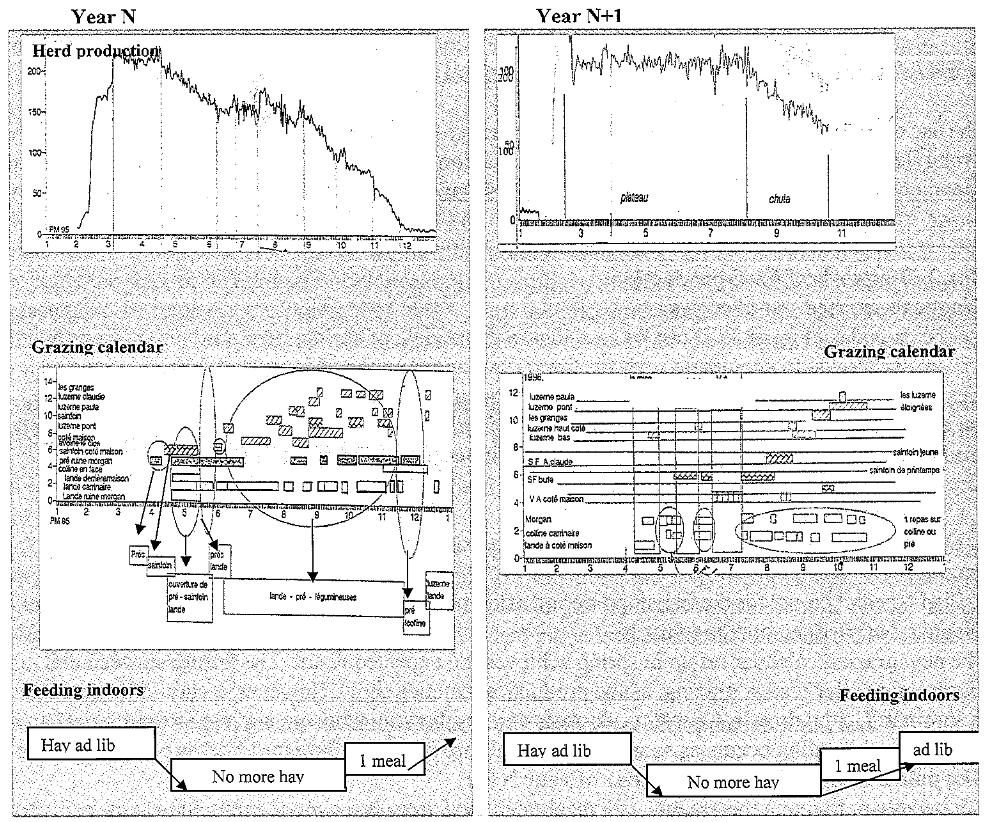

Figure 3. An example: calendar of herd management.

Box 2. Progress of herd management and grassland management.
The organisation of herd management, year N
The herd is managed in a single batch, with births grouped by season. The herd grazes from early April to December. The grazing land provides the whole diet from mid April to the end of September. During the lactation period 'M' supplements the diet with 700 g of grain (1/3 barley, 2/3 concentrate). He keeps a field of sainfoin for spring grazing. The other fields of pulses, mown in the first cut, are only grazed in the summer and autumn.
Organisation of grazing: *every season* 'M' *associates pulses, natural grasslands and rough grazing.*
The flock is put out to grass on natural grassland in early April. This transition period lasts for 10 days until the end of hay.
In spring (mid April to mid May): Continuous grazing on four fields of grass and heath, with the supplementary use of the field of sainfoin.
Late spring (mid May to the end of May): the sainfoin is finished. The herd grazes on the grassland they have used since they were put out to grass and on ungrazed heathland.
Transition from spring to summer. The oats/vetch mixture is used to supplement spring and summer grazing on heathland and natural grassland.
Summer-autumn: One meal on pulses (used in rotation) and one meal on grassland and heathland.

The new organisation in year N+1 solves the problem of production management in full spring. However, the analysis of its progress highlights a new problem: the risk incurred if the only resources to be grazed in summer are fields of sainfoin planted in the current year (see Box 3).

Optimising grazing with respect to parasite infection

The use of grazing land exposes the animals to the risk of parasites, the most common being digestive strongyles. In conventional livestock farming, the control of this parasite is based on the regular use of chemical worming treatments. However resistance to these molecules is increasing in worm

Box 3. Diagnosis of herd production.
Diagnosis carried out over year N
On the calendar, (Figure 3), it can be seen that in the middle of spring, herd production drops by 25% in six weeks. In agreement with the farmer, we assumed that this marked drop is related to the progressive lack of sainfoin and continuous grazing on too large an area. At the end of spring, the effect on production of feeding green oats for four days is immediately apparent. In summer, production stabilizes as soon as the second leguminous crop (alfalfa) can be grazed.
Key points to plan the calendar for year N+1
1. Organise rotations on the spring fields.
2. Do not under-estimate the fields of legumes needed for spring grazing. Reconsider cutting vs. grazing.
3. Plan 'special crops' for the transition period after the end of spring (approximately 1 month).
Diagnosis carried out over the year N+1
The new grazing calendar set up in spring achieves the expected result. The farmer succeeds in managing regular feed at grazing, as the production kinetics show. However, it should be noted that in summer: (1) the drop in August production starts at the time when young leguminous plants are used; (2) stabilization occurs as soon as the animals are moved to 3-year old fields of alfalfa.
Key points to include in the calendar of year N+2:
Is it necessary to retain the grazing of 1 meal on a good area, on *young* leguminous plants in summer? In this case, would it be necessary to supplement this meal by another area (grassland, alfalfa in year 2, sorghum…)?

populations (Jackson and Coop, 2000). In organic farming, there are strict quotas concerning the use of synthetic molecules. The management of parasites therefore has to reconcile two contradictory aspects: *greater exposure of the animals to risks of parasites and a reduction in the possibility of treatment*. Whether in conventional farming or organic farming, it is important to develop innovative diagnostic monitoring tools at the level of the animals or of the management systems to avoid massive recourse to chemical substances. We sought to develop a tool for the diagnosis of parasitic risk factors that can be used by farmers and technicians; it is based on the analysis of herd management practices in relation to the kinetics of herd milk production.

The infestation of pasture by nematodes is related to their use by the animals

The infestation of a pasture depends on the number of larvae present which, in turn, is linked to the number of eggs deposited by the animals that graze there. The nematode cycle lasts for about three weeks but the larvae can continue to infest the land for several months. The infestation of a field will thus depend on the stocking density (number of animals/ha), the length of use by the animals, and the condition of the animals that graze there. The more the animals use a field, the more they contaminate it. And when an animal has just used a contaminated field and moves onto another field, it will contaminate the new field. However, certain agricultural techniques (ploughing, mowing), or significant and durable weather phenomena (frost or long drought) can help reduce the rate of infesting larvae. Consequently, it is particularly important to identify periods in a grazing calendar when the fields are left to rest, while keeping in mind aspects related to avalaibility of ressources and their valuation to reach expected production rates. in terms of infestation, in temperate conditions, management of grassland with short rotations using a number of small fields has the same consequences as simultaneous and uninterrupted use of all these fields. In this case, with respect to the risk of parasites, these fields can be considered as a single block.

Estimating risks from practices

Armed with this knowledge, a group of agricultural advisers and researchers designed a diagnostic approach to the risk of parasites inspired by HACCP approaches and a previous approach (PEP, 2007; Hoste *et al*., 2005). From the analysis of farming practices and the grazing calendar, it is possible to estimate the state of infestation of fields and of the animals, in order to calculate the risk of parasite infestation. To return to the example of 'M's' farm, the grazing calendar for year N+1, which was satisfactory as regards herd production management, may face a risk of parasite infestation. In 'M's' context, it is useful to question:

- The regular use of the 'Morgan' field after putting the animals out to grass for the winter. The periods when this field is not used are too short to have a positive impact on the rate of larvae present.
- The return in early summer to the 'Bute' field of sainfoin that was used in spring.

Taking the above knowledge into account, we suggest that the way of managing these two fields could lead to a risk of infestation in summer. To limit this risk, two methods are possible: (1) subdividing the fields of natural grassland called 'Morgan' and managing them as fodder areas, with rotations rather than continuous use and (2) leaving a longer interval between the two uses of the 'Bute' field of sainfoin.

Simulating new organisations taking into account both production needs and risks of parasites

With these two angles of analysis (production and health risk), the farmer can refine his organisational principles to design the grazing calendar and new organisational rules. Thus, in our example:

- associating leguminous crops (1 meal after midday) and heath land (1 meal in the morning), throughout the grazing season;
- not under-dimensioning the fields of legumes reserved for the spring;
- managing the fields in rotation, and leaving sufficient time before returning to the same field;
- specifically allocating resources for the transition period in late spring;
- carefully watching the use of young fields that are sensitive to drought in summer.

The farmer can also define ways of monitoring the progress of the farming year by identifying the critical periods, the objects that have to be watched, and corrective measures that can be applied. For example:

- Carefully monitor the spring-summer transition period: *If* I see a persistent drop in production and the resource in the fields becomes insufficient in spring, *then* I can mobilize a particular 'buffer' resource while waiting for second cut regrowths (e.g. valley floor reserved for this purpose).
- Monitor the condition of the animals if the spring is very rainy and if it is necessary to return to the spring fields: *if* I see that the animals have soft droppings, or their coat is dull *then* I can assume that there is parasite infestation and take the necessary measures.
- Monitor the use of young fields of sainfoin in summer, (because they will be sensitive to drought).

Discussion

Representing the action to help in the interpretation and construction of a shared diagnosis

The diagnostic approach we have just presented is an iterative approach, from action to analysis. The chart of the progress of herd management and the use of grazing land plays the role of an intermediate object (Vinck, 1999), that facilitates dialogue between the technician and the farmer but also helps the farmer to stand back and judge the situation for himself.

The chart makes it possible to link the short and the long term and therefore connect a collection of elements which might seem irrelevant when considered individually. It also helps clarify tactical decisions, and analyse the effect of these decisions on herd management. So it involves a true process of abstraction, from the calendar, which makes it possible to pass from a factual representation to the formalisation of an organisational method, and dialogue with the farmer on the underlying logic.

As recalled at the beginning of this paper, several interpretations can be made of management progresses leading to different diagnoses. The representation makes it possible for everyone to clarify the elements they use to construct their interpretation. Thus the dialogue between the farmer and the technician can begin on these respective keys to understanding. In the end, the diagnosis resulting from this exchange of views on ways of viewing things will be neither completely that of the technician, nor completely that of the farmer. The way of formulating – in writing – this combined interpretation, and the question(s) to treat that result from it, is a crucial point that will influence the courses of action considered.

In the 'search-for-solutions' phase, the chart makes it easier to imagine new organisation scenarios. Here we define 'scenario' as a unit formed by the description of a future situation and by the advance of events – which must be coherent – making it possible to move forward from the original situation to a future situation (Godet, 1991). Several scenarios can be imagined, represented, and discussed, before finally choosing only one believed to be both desirable for different reasons (technical, economic, labour) and feasible in the eyes of the farmer (taking into account farm operating costs, or interactions with other activities).

A long term learning process

In the long term, this approach can be renewed here and there. From these successive analyses, placing the action in relation with the interpretation (Figure 4), the farmer and the technician construct new knowledge they use to design new forms of organisation aimed at improving the points considered to be problematic. They also create means of monitoring and analysing the situation, based on observation of the herd and of the resources, in order to readjust management if necessary. In this way a succession of trail and error is obtained leading to a process of organisational learning.

These reference points and knowledge are hybrid know-how resulting both from observations and analyses of how the action proceeds and from technical models (e.g. the physiology of lactation, vegetative cycles, or parasite cycles). This hybrid knowledge is then formulated in the form of rules that can be analysed in relation with the action.... *If I see that...(and that...)...then...* The formalisation of this know-how, and its organisation, for its subsequent mobilisation remains an open question, whether the aim concerns farm management (for the practitioner) or support and guidance (for the adviser).

This aid to diagnosis will not inevitably move in the same direction depending on the life cycle of the farm concerned. For farmers who are just setting up their business or farmers who wish to make major changes to their herd management, this approach is a way of acquiring knowledge and know-how that is internal to the farm. For example, it may be useful for goat farmers engaged in a process of moving to less intensive management practices. For an experienced farmer who has tested the robustness of his herd management over a long period, the exercise of explaining his organisation and taking time to analyse it with someone from outside the farm, allows him to call into question possible organisational routines, which might imperceptibly lead to risky situations. But this approach can also be a way of anticipating and monitoring a period that this experienced farmer is able to manage carefully.

New roles for the adviser and the researcher

In this role, the adviser guides the reflexion, and helps in the expression the project. His role is not the that of an expert, from whom specific information would be expected to solve a particular problem. This approach can only be used if the farmer and the technician are indeed engaged in a logic of exploration. The role of guide modifies the classic format of 'agricultural advisory service' and the linear dissemination of research knowledge towards technical institutes and farmers. By helping the expression of a particular project, these approaches have shown their effectiveness in the context of research and development. Their extension will depend on the organisation of advisory structures,

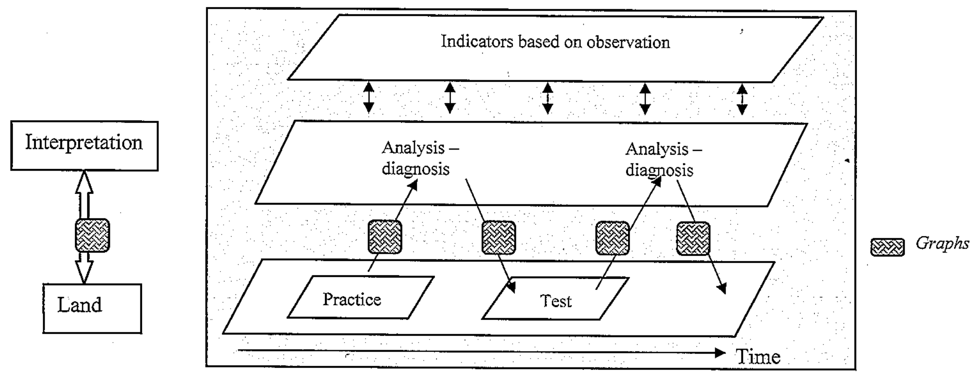

Figure 4. An iterative approach between action and analysis.

and the missions intended for advisers. Finally, the context of Mediterranean regions, in which farmers aim to find a balance between a range of different resources, makes it necessary to search for alternative ways to reinforce the capacities of management of the grazing herd. However, we put forward the hypothesis that it is a challenge for farmers in intensive systems, who have often lost the know-how to manage grazing land and who, taking sustainable agriculture into consideration, are confronted by the necessity of moving to less intensive practices.

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