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Changing land uses in Provence (France) Multiple use as a management tool

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SUMMARY - Understanding the present land use pattern requires a knowledge of the historical process which has shaped the agricultural systems of a region. For this reason the transformation of the French Mediterranean region over the past several centuries is discussed. Agriculture in the 19th century concentrated on production of cereals, which were grown on 80-90% of the cultivated land. Fertility of fields was maintained with animal manure from sheep, goats and other stock. A fall in prices at the end of the 19th century created a crisis and a need to modernize. Modernization resulted in intensification of cultivation on the best land, specialization of production, and extensification of grazing. Extensive landscapes are subject to burning and some marginal lands have been converted to forests, which are also sensitive to fire. Solutions to management of marginal landscapes will require an integrated approach in which the objectives of grazing, forestry and fire control are combined. New functions of the landscape are needed in order to respond to continually changing demands, and these must involve multiple use.

Key words: Provence, environmental history, grazing, forestry, fire, multiple use, landscape, France.

RESUME - "Modifications de l'utilisation des terres en Provence (France): l'utilisation multiple comme outil de gestion". Une bonne connaissance du passé historique qui a façonné les systèmes agricoles d'une région est indispensable pour comprendre l'utilisation actuelle des terres. La transformation des régions méditerranénnes françaises au cours des siècles derniers est étudiée ici. Au XIXème siècle, l'agriculture s'est attachée essentiellement à la production de céréales, production qui occupait 80-90% des terres cultivées. Les champs étaient fertilisés avec du fumier provenant d'ovins, caprins et autres animaux. Une chute des prix à la fin du XIXème siècle a mené à une situation de crise, une modernisation s'avérant nécessaire. Cette restructuration a eu comme conséquence une intensification des cultures sur les meilleures terres, une spécialisation des productions, et des pâturages encore plus extensifs. La technique du brûlis est appliquée aux grandes étendues de terre, et quelques espaces marginaux sont devenus des forêts, vulnérables aux incendies. Une approche intégrée combinant les terres de pâturage, les forêts et le contrôle des incendies, est nécessaire en vue de l'aménagement des régions marginalisées. Il faudra planifier de nouvelles utilisations des terres afin de satisfaire une demande qui évolue sans cesse, et un système à productions diversifiées est à envisager.

Mots-clés: Provence, histoire de l'environnement, pâturage, espaces forestiers, incendie, production diversifiée, paysage, France.

Introduction

Discussion of agro-sylvo-pastoral development in the context of the French Mediterranean region is usually understood to mean the combination of two man-made systems of organisation in the same space: wood production (forestry) and livestock farming (a farming system). The functioning of the two types of system has different results: the protection and/or production of trees/wood on the one hand and the sustaining of a livestock system on the other. The two features may nevertheless overlap considerably under our conditions: protecting woodland against fires involves controlling the grassy, shrubby understory which might be one of the consequences of the presence of animals. This vegetation - unwanted by the forester - can form an important forage resource at certain times of the year.

This combination leads to creating sylvo-pastoral systems which may have different scales and speeds of operation in both space and time:

- a degree of diversity in space is the result of both the ecological conditions (soil/climate factors, exposure, altitude) and past and present cultural practices: seeded

grassland, formerly cultivated fallow, high altitude grassland, coppice (and its succession of plots more or less regularly exploited), reforestation (different ages and stages of regeneration, etc), burning for grazing, etc.

- time, which must be considered on several scales:

* seasons within a year or several pluriannual periods. This is the scale of adjustment for the daily decisions of the livestock farmer and the forester in relation to their immediate objectives. The spatial scale involved is already different for each of them. The livestock farmer perceives the forage resources at a given moment in a portion of space whereas the forester manages a development which does not respect natural heterogeneity in the same way.

* human generations; this is the time scale for the production of wood resources and their exploitation and also that of the social and economic evolution which questions their finality and which governs the rate of evolution of techniques, modes and types of agricultural production (and hence animal husbandry): the finality of a territory can thus change for reasons unconnected with the rate of endogenous regulation mechanisms. This movement has accelerated since the 19th century.

Sylvopastoral systems thus consist of a link between an animal husbandry system and the development of a forestry area. I shall start by describing how the present situation is the result of the history of the rural societies concerned and their relations with their environment; this is followed by discussion of the essential parameters of each of them and illustration of their interest through different situations in which there is interaction between animal husbandry and forestry.

I - The present situation is the product of history

Understanding the present use of space on the northern shores of the western Mediterranean requires examination of the recent history of agrarian systems which were both moulded by the landscapes and created them. Indeed, this involves the relations between rural societies and their environments, the constraints imposed on the latter and the actions of them to achieve their objectives of survival and reproduction.

The natural areas in the Mediterranean basin have been strongly marked by man. Some authors (Di Castri, 1981; Le Houerou, 1981; Naveh, 1982; Braudel, 1986) consider that the process probably goes back 100,000 years for hunting and gathering societies with knowledge of fire and at least to the first neolithic farmers and grazers from 5,000 to 10,000 b.C. These people and the agrarian societies which followed them moulded the very artificial landscape that we know today and which is the result of centuries of clearing, cultural practices, grazing of flocks and herds, fires (more or less well controlled), coppicing and high forest or orchards, the transfer of fertility from rangeland to arable land, etc. The objectives and techniques allowed for natural heterogeneity as best as possible; they were closely connected with the conditions in each type of space (depth of soil, slope, climate, etc) and their effects on the different strata of vegetation with their own levels and production periods. The result is a very varied landscape which is far from being the simple expression of "natural" plant communities. In the words of Walter (1968), it has become a "mosaic of innumerable variants of different degradation and regeneration stages".

One of the main limiting factors is nevertheless the summer drought which is of varying intensity according to climatic zone. This has a number of structural consequences such as the importance of ligneous plants of all sizes and the relatively limited development of herbaceous resources (particularly scarce in summer). There are functional effects such as strong dependence on natural or artificial water supply and high fire risk. The latter is a characteristic feature of "natural" Mediterranean environments (maquis, garrigue and forest). It profits from the multi-stratified nature of these types of vegetation, as mentioned by De Montgolfier (1986).

Today, the Mediterranean landscape of Europe frequently displays the contrast of two types of space: on the one hand the "agricultural plains and valleys" with intensive cultivation of vines, fruit trees, flowers, vegetables, etc., and the "hills" near the coast or further inland which are becoming covered with brush or deforested but which are rarely used for rational forestry production. This characterises the abandonment and undervaluing resulting from the collapse of the old agrarian systems at the end of the 19th and beginning of the 20th centuries.

This transformation phase is discussed after a few words about the situation in the early 19th century, which must have been fairly similar to that of the preceding centuries. The situation then was probably caused by the succession of practices whose technical level had hardly changed over the centuries. The only modifications were the result of demographic changes, i.e. the large population movements identified since the Roman period (Fig. 1). The whole of this period was marked by fairly strong economic self-sufficiency resulting from intensive use of all the resources available.

These old systems were changed fairly abruptly as a result of a population explosion and modernisation processes. Some of these features date back to the end of the 19th century whereas others occurred in the 1960s.

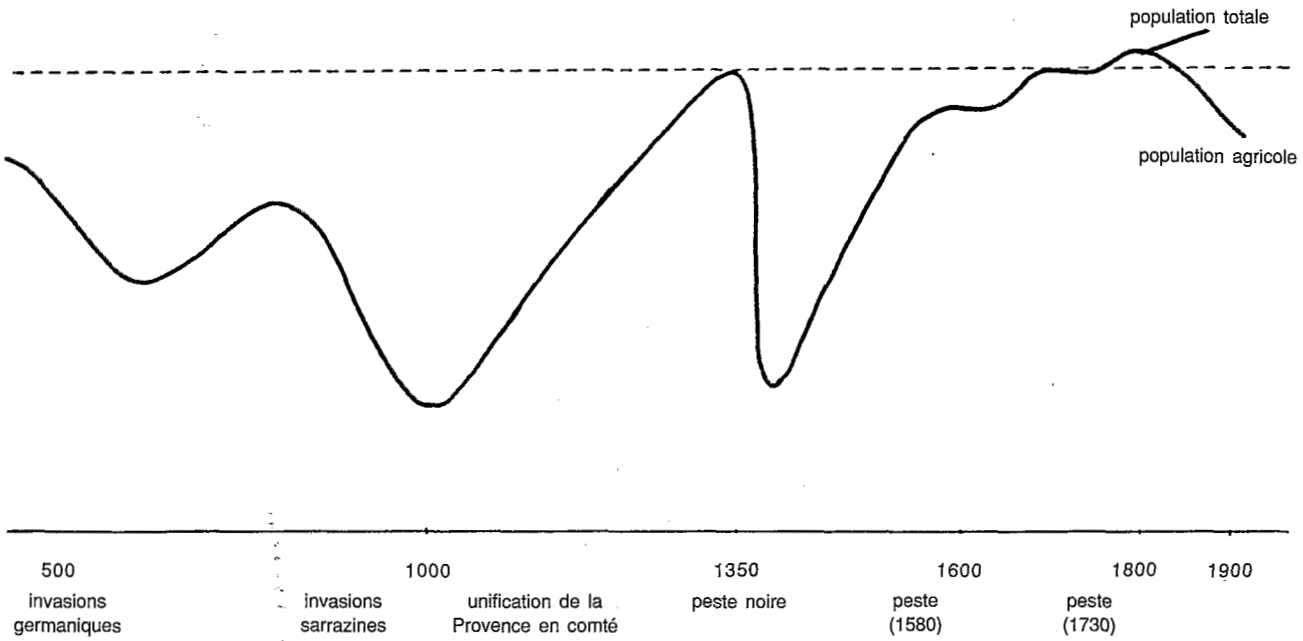


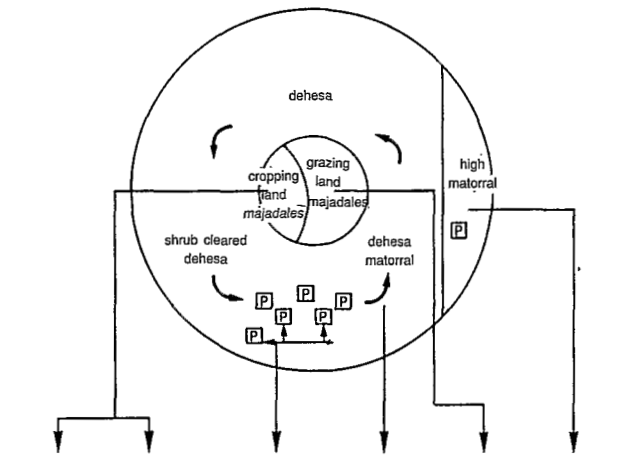
Fig. 1. Estimated population curve of Provence in the last two millenia (from Jacob, 1986).

Hard work and huge matter transfer

These societies did not possess much capital and used a very large amount of labour on land of uneven quality, the best of which was reserved for grain crops. In addition to producing firewood, the other land was expected to support a large transfer of biological matter over the centuries. This was the result of various human activities (exploitation of small ligneous growth) but above all of livestock (particularly sheep) to "collect" the vegetation, converting it into organic matter and returning it to the soil, when kept on the cultivated land.

All these cultivation and picking activities were organised in space and time to match as best as possible the working constraints and farming methods, climatic conditions, geomorphological structures and floral and architectural composition of the plants themselves. For example, in the South of France different hill and plain zones were used for *ager*, *saltus* and *silva*, whereas in Spain all three were grown in the same space (organised in time) in the "dehesa" and "montado" (Fig. 2).

These societies produced little over and above their own requirements (food and heating), selling just enough to buy clothing and pay taxes. However, they were not egalitarian and the most important structures resulted in a certain accumulation of capital. These social differences increased with time and 19th century population growth. The latter intensified the processes of export of matter and led amongst other things to a serious ecological crisis in some of these societies. They were



irrigated zone	cropping land majadales (4-8 years rotation)	shrub cleared dehesa (15-20 years rotation)	dehesa	grazing lands majadales	high matorral
• fodder crops	• fooder crops • cereals (grains) • stubbles • herb. GR	• cereals (grains) • stubbles • herb. GR • charcoal	• herb. GR • acorns, pruning GR • Timber • charcoal • cork	• herb. GR (only for lambs)	• shrub fodder resources • charcoal

herb. GR = herbaceous grazing resources

Fig. 2. Schematic presentation of the functionning of a traditional farming system in the Andalusian "dehesa" (from Joffre *et al.*, 1988).

incapable of resisting competitive price phenomena resulting from the development of transport and comparison with "more favoured regions" (Russian wheat was shipped to Marseilles from 1846 onwards). Thus there was a great pressure on a badly paid labour force to leave, attracted by the strongly developing secondary sector.

These processes can be illustrated by examples in Spain and the South of France.

1. Organisation of cultivation

The success of whole organisation was determined by the cereals which were grown on 80 to 90% of the cultivable land. Approximately 250 kg of grain was required per head whereas yields were commonly about 5 to 10 quintals (1 quintal = 100 kg) per ha (with slightly over 1 quintal per ha sown). There was a system of fallows, at least biennial. Cultivable land soon became inadequate as these yields and the fallow system meant that nearly 1 hectare was required per head and this was not available for many families. Woodland was then cleared, i.e. slash and burn cultivation generally carried out every 25 years. Three successive cereal crops giving about 3 quintals/ ha/year were usually grown after the wood had been cut and the remains burned. Thus 40% of the land cultivated annually could be cleared woodland. This meant that these forests produced not only approximately two cubic metres of firewood per hectare per year (plus 1 to 1.5 cubic metres of kindling), which was roughly the amount required per head per year, but also the equivalent of 0.36 quintal/ha/year of cereals (i.e. 7 hectares per inhabitant!). It can be seen that population growth would soon reach its limits unless rotations were shortened, yields improved or unless there were complementary activities. The poorest people (75% of the families in certain villages in the Var possessed less than 1 ha) sold their labour in medium-sized or large holding. Vines and olives had often been combined with cereal growing in the latter since Roman times. According to Jacob (1986), in certain communes in the Var department, where the useful agricultural area produced only half of the cereals required, the other half came from the sale of wine and olive oil (a monetary equivalent of 1000 quintals from 135 ha whereas 170 ha would have been necessary for wheat!).

The reconstitution of the fertility of such a system depended to a great extent on livestock and in particular on sheep, for which this was one of the prime functions (before wool production); it has been said that sheep were "the obligatory companion to cereal growing" in these regions (Blanchard, 1945). Another method was to make compost from the foliage of small woody plants gathered in the woods and on the moors (box, broom, dead oak leaves, etc.) and piled up in the streets and chicken runs, etc. Gathering could be carried out in this way twice a year, often according to a layout decided by the Forestry Service and with "cutting" planned every three or four years (De Bonneval and Lachaux, 1987; De Bonneval, 1990).

Forage crops covered no more than 10% of the useful agricultural area at the beginning of the 19th century. They consisted mainly of unfertilised alfafa and sainfoin. The development of phosphate fertilizers from the 1840s and 1850s onwards made it possible to incorporate these crops in the rotations. Cereal yields therefore improved slightly; they then improved again with the introduction of artificial fertilizers in the Mediterranean regions between 1880 and 1920 and increased sharply towards the middle of the 20th century (Fig. 3).

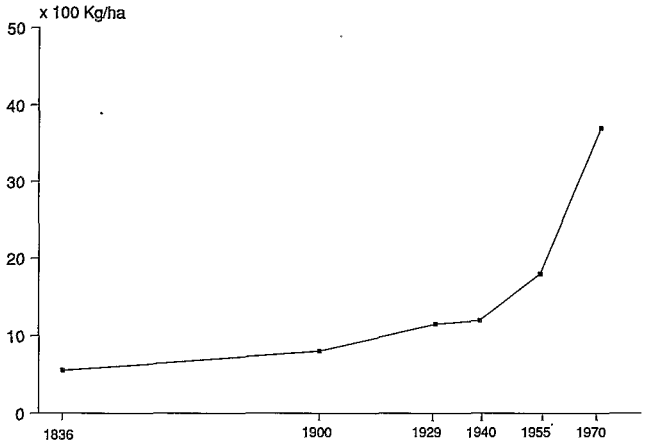


Fig. 3. Progression of average wheat yields from 1836 to 1970 in the Department of Alpes de Haute Provence (from de Bonneval and Lachaux, 1987).

2. Animal husbandry

Oxen and horses (from the end of the 19th century) were used mainly as draught animals and consumed the small amount of forage that was grown. Most families had a few goats which produced a little milk for domestic purposes. They were grazed in the woods and on moorland but were usually tied up along paths, hedges and the edges of woodland when conflict with the forestry service led to strict regulations.

Piacere (1987) describes well the position of goats in 19th century rural life, and in particular in the present Alpes de Haute Provence administrative department

where goat rearing has always been of some importance (Fig. 4):

"In the Lower Alps at the beginning of the 19th century, goats were part of a polyculture-animal husbandry system whose prime objective was to meet family requirements. Their role was to provide dairy products and manure for arable land and they were extremely valuable, especially for poor farmers who possessed no other livestock. Goats were generally grazed on common land. As they were more willing to graze foliage than sheep, the goatherds took them preferably into the woods. Because of the pressure thus exerted on forest areas, officials at communal level or higher (prefectoral, royal, imperial, etc.) periodically applied measures to protect the forest by forbidding clearing and strictly limiting grazing, especially by goats which attacked the trees directly. The Department Records at Digne possess the record of such a prefectoral order dated 1801 which strictly limited goats to one per family. This caused an outcry in rural areas and the mayors of almost all the villages sent protests and requests for exceptions with arguments such as: "Most of the inhabitants have no other resources for fertilizing their land and for subsistence; it is impossible to prohibit them without people dying or having to leave". The administration finally withdrew the measure. Commissions of enquiry were appointed to go to the villages and decide, case by case and according to village grazing and forest resources, how many goats could be tolerated. This resulted in the publication in 1818 of a new prefectoral order mentioning the number of goats permitted in each village in the department...

Goat breeding dwindled everywhere in the 20th century. The manufacture of *Banon* cheeses declined and the development of commercial exchanges reduced the advantage of domestic milk production. Goats disappeared as farms specialized more and more in plant crops...

Thus, the goat population of the Alpes de Haute Provence department decreased by two-thirds in a century and a half, and very little moorland and forest vegetation was grazed because of the charge in the way the flocks were managed".

Sheep farming was the main type of animal husbandry. Flocks were small (10 to 30 head) and nearly half consisted of wethers weighing an average of 20 to 25 kg which were slaughtered at 3 to 4 years old after producing several fleeces and first of all a great deal of manure. It is considered that ten sheep produce 7 tons of manure per year from use of fallows, rangeland and woodland, i.e. from fairly poor resources relatively well-used by wethers with slow growth and very small requirements. Acorns were reserved for ewes which had lambed and for the final fattening of pigs. In 1827 at Rougiers (Var department), there were 430 ewes or sheep which

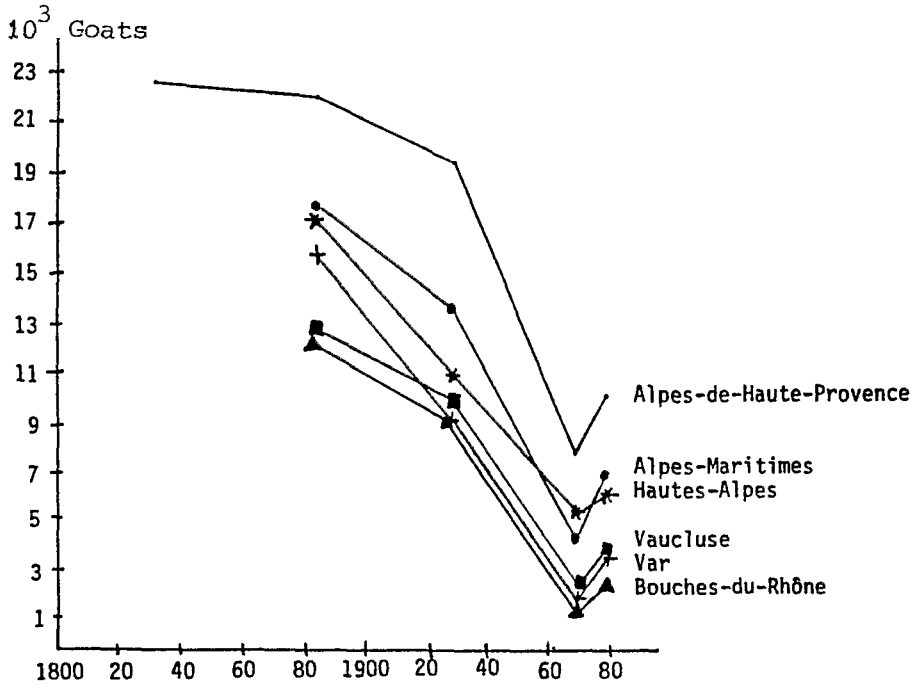


Fig. 4. Changes in goat numbers in the 6 departments of Provence (from Piacere, 1987).

produced approximately 300 tons of manure on 488 ha, thus providing 1.2 tons per hectare of fallow, i.e. approximately 12 nitrogen units which guaranteed 4 quintals of wheat (Jacob, 1986).

In certain areas in the southern Alps where the flocks were taken to winter in the Var coastal plain, loss of manure was thus considerable, but there was no question of giving hay to wool-producing animals and the land was too poor for them to graze throughout the winter. The *ramée* (collection of leafage) was thus practiced in certain valleys; oak shoots and leaves (*Quercus pubescens* in France and *Quercus cerris* in Italy) were collected at the end of September once every 3 to 5 years (low pollarding) (Salvi, 1982; Lachaux, *et al.*, 1987). The faggots were stacked and given dry to the sheep in the winter and thus turned into manure. Leaf silage practices have been reported in Italy and in the Lyons area (Sigaut, 1987). According to the latter author, even working or fighting animals such as horses were fed with tree leaves until the scythe was invented.

A special practice - night folds - has been found in the Massif Central and described by Loiseau (in Larrere *et al.*, 1983) (Fig. 5). In a village in the "Dômes" area with 180 ha of land, a flock of 1000 ewes was kept for about 150 nights each summer in 4000 m^2 per night, thus returning 41 kg of nitrogen, 6 kg of phosphate and 31 kg of potassium per hectare from 54 ha of fallow during the summer. Half of this was from rangeland and half from fallows. This was carried out roughly every 6 years on the same plots which thus produced 12 to 15 quintals/ ha of rye for the first of the three intermediate harvests. Thus in 1850, the Dômes fed 60 inhabitants per km^2 with an extremely complex system of sustaining fertility (Fig. 6).

Other agrarian systems in the Massif Central had an extremely hierarchic system of summer grazing (Bazin, 1986). The number of sheep permitted in summer pasture was directly related to the number of hectares to be fertilized by each farmer (10 ewes for 5 ha, 40 for 25 ha, etc.). Knowing that a farmer was "rich" from 15 hectares onwards, it can be seen that production and accumulation capacities were far from being evenly distributed. The poor succeeded in sustaining their labour capacity, the middle layers managed to produce a small surplus and the richest could accumulate money to purchase means of production or land if any became available. De Bonneval (1990) observed identical practices in green oak copsewood in the Gard department. But what happened to such systems when they had to face very different economic and social systems?

3. Very fragile systems

A widespread fall in prices - at least of cereals and wool - took place at the end of the 19th century because of the development of transport and the marketing of

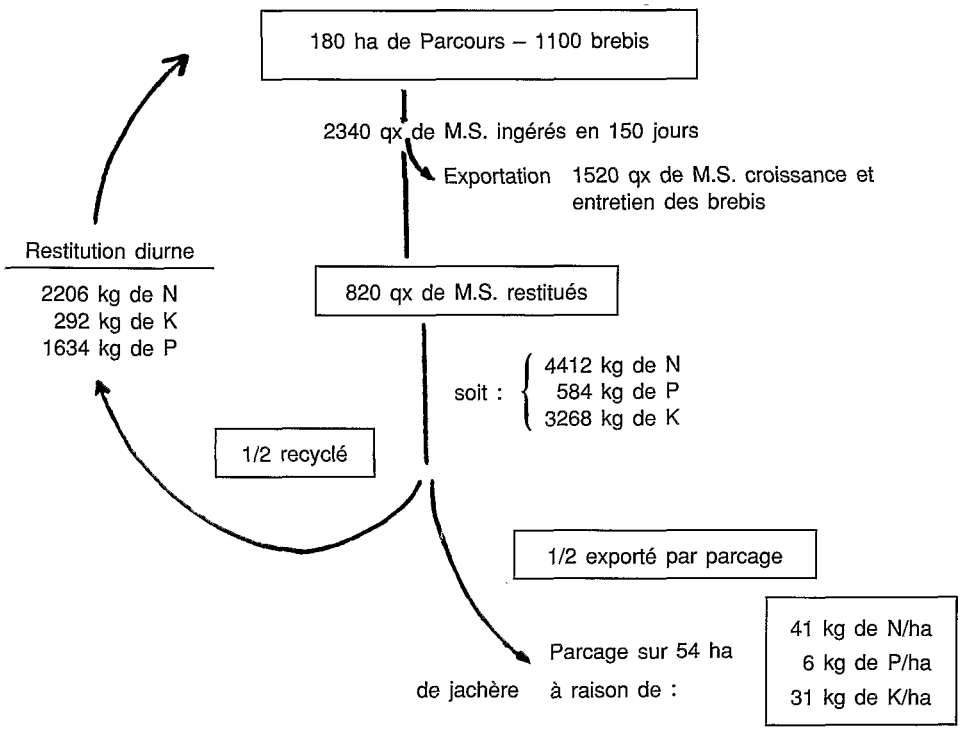


Fig. 5. Quantification of fertiliser transfers from rough grazings to tilled land at La Garandie in 1850 (from Loiseau in Bazin, 1986).

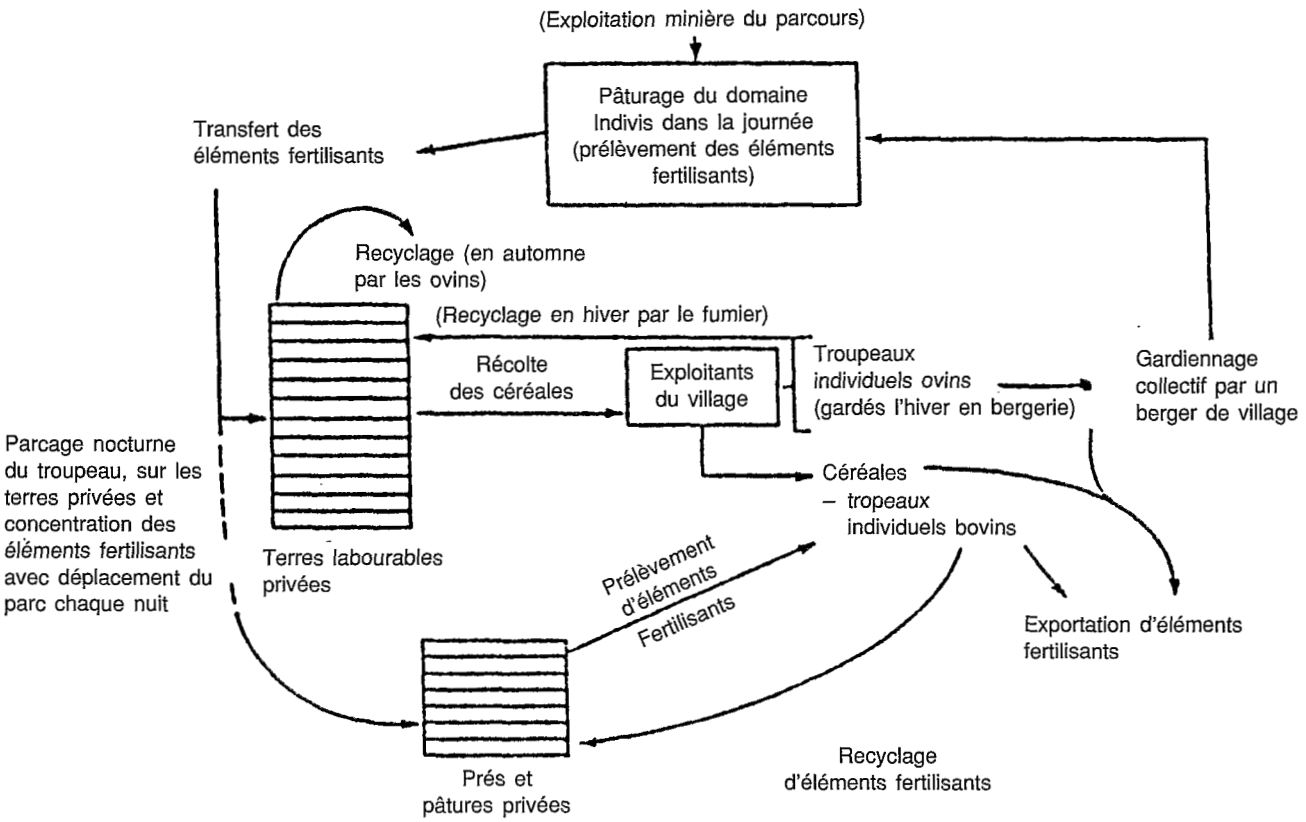


Fig. 6. Sustainability of soil fertility in the Dômes agropastoral system during the XIXth century (from Bazin and Larrere, 1983).

produce from far away (cereals from the north of France and Russia, wool from Australia, etc.).

At the end of the 19th century, a worker produced 100 quintals of wheat per year in the north of France, half of this in the Dômes, and a quarter in the Alpine foreland (Bazin, 1986). These areas suffered rural exodus on a huge scale from 1850-1860 onwards. The Basses Alpes department lost practically a third of its population (Fig. 7). France lost 1.2 million hectares of cereals from 1910, 200,000 ha of which were in the coastal area in the Var department and 176,000 in the Alpes du Sud area alone (Duby and Wallon, 1976). Wine-growing developed on the coast and made winter transhumance of the alpine flocks increasingly difficult. 100 ewes producing about 360 kg of wool fetching 3 F/kg represented the equivalent of 36 quintals of wheat in 1860. In 1892, the equivalent was only just 17 quintals with the price of wool at 1 F/kg.

The number of sheep in France thus decreased from 32 millions in 1846 to 21 millions in 1900 and even 10 millions in 1923!. The sale of the flocks enabled some farms to invest capital in draught animals, whose number increased by 10 to 20% (a horse could be used to farm 3 ha, i.e. twice as much as manual labour, and

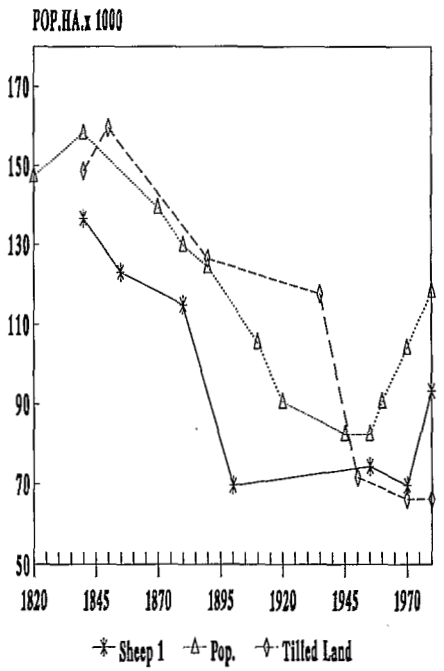


Fig. 7. Changes in population, tilled land and sheep numbers in the department of Alpes de Haute Provence from 1850 to 1980 (from Bazin, 1986).

in addition produced 25 times as much manure as a ewe since it was all collected at the stable), agricultural equipment, wineries or even land or industrial capital in the large towns nearby. Those who had no land or only a little purchased part of these flocks to form large specialised sheep- rearing units. These were the new shepherds.

Wood was used extensively both for domestic purposes and for the early decentralised industries (glassworks, potteries, tanneries and soap factories) and the price had doubled between 1810 and 1860 (1.5 to 3 centimes/kg) but was soon in competition with English coal. The same happened to cork with competition from Spain and Portugal since 1877 onwards and above all, from Corsica, Algeria and Tunisia after the protectionist measures of 1891. One hectare gave a return of 100 F in 1850 but only 40 F in 1900 and production fell from 110,000 to 30,000 quintals per year. Conflicts between users and owners - settled to the advantage of the latter by the various political regimes - became obsolete. Most uses of forest disappeared except for hunting, and this had financial effects on a number of "forestry" communes (De Bonneval, 1990).

How could this new rural society with its reduced population exploit an area which was frequently managed to the limit of ecological sustainability? How did the new production systems become established?

A long period of concentration and specialisation of activities

Confronted with the crisis of modernisation, traditional agrarian systems evolved in very different ways according to local conditions: distance from industrial centres, climatic constraints, capitalisation capacity, etc. Some concentrated on specialised use of land and others practiced extensive farming.

1. Concentration of activities

This occurred when only the best agricultural land was used and when reforestation was carried on the most suitable land or the land most at risk from erosion. However, this movement of spatial concentration of labour went hand in hand with a call for capital which had been accumulated in the preceding phase or even borrowed.

There was thus specialisation in sheep-farming, based on rearing lambs indoors or outdoors depending on the climatic conditions, farm structures, etc. Most farmers in the southern Alps practiced the former technique and produced 100-150-day-old lambs reared in the fold and fed on hay, chickpeas and cereals (and sometimes even finished outside the region). Slaughterhouses were built in Die (Drôme) in 1905 and in Sisteron (Alpes de Haute Provence) in 1920 and specialised in winter lambs (Christmas to February) sold at high prices and bred out of season thanks to controlled feeding of ewes. 5-6-month-old outdoors lambs were still produced during the usual season especially in the large transhumance systems and also in the forealp region.

This resulted in considerable decrease in the grazing pressure of preceding years. The control of the sustainability of grass resources was not possible without the already frequent use of winter burning. Village land structures changed (Fig. 8) with the development of forage crops and wooded areas.

Flocks generally consisted of 20 to 50 ewes and 100 to 200 in the coastal plains. There were practically no more wethers. Distinction began between specialised breeds (the "Préalpes" Flock Book was started in 1948 and the Domaine du Merle shepherds school, specialised in Merino sheep, was opened in 1930).

The area cultivated by a much-reduced population was limited to the best land, that which would be embanked and irrigated (sometimes only 50% of the land previously used). Rotations were much faster, combining potato, forage crops and often two cereals in succession (whose yields increased from 5-6 to 9-12 quintals/ha at the beginning of the 20th century).

However, the sustainability of these farms was poor. The number of holdings in the Alpes de Haute Provence department fell from 26,800 in 1892 to 9060 in 1955 in spite of the "respite" provided by lavender and then lavandin crops which at least made it possible to buy a certain amount of agricultural equipment and rearing building. The rural landscape changed completely (Fig. 9).

Specialisation became extreme in the coastal areas. The plain was used for horticulture, fruit and vegetables and wine-growing. Some marginal land and all the moorland and rangeland was left to the large flocks of sheep which were moved to alpine pasture in the summer. There was a 50% increase in land declared as wooded for land registry purposes (Table 1, after Rinaudo, 1980).

The position of the forest in this evolution was described by Hubert and Guerin (1987). A voluntary reforestation policy was set up during the Second Empire. When made obligatory, it frequently met resistance from local communities. The conditions of reforestation of mountain zones were not specified until legislation was passed in 1882 (restoration of mountain land). Very large areas were concerned in the departments in the southern alps and were acquired by the state: over 50,000 ha in the Hautes Alpes and nearly 100,000 ha in the Alpes de Haute Provence, i.e. 10 and 20% respectively of the territory of these two departments.

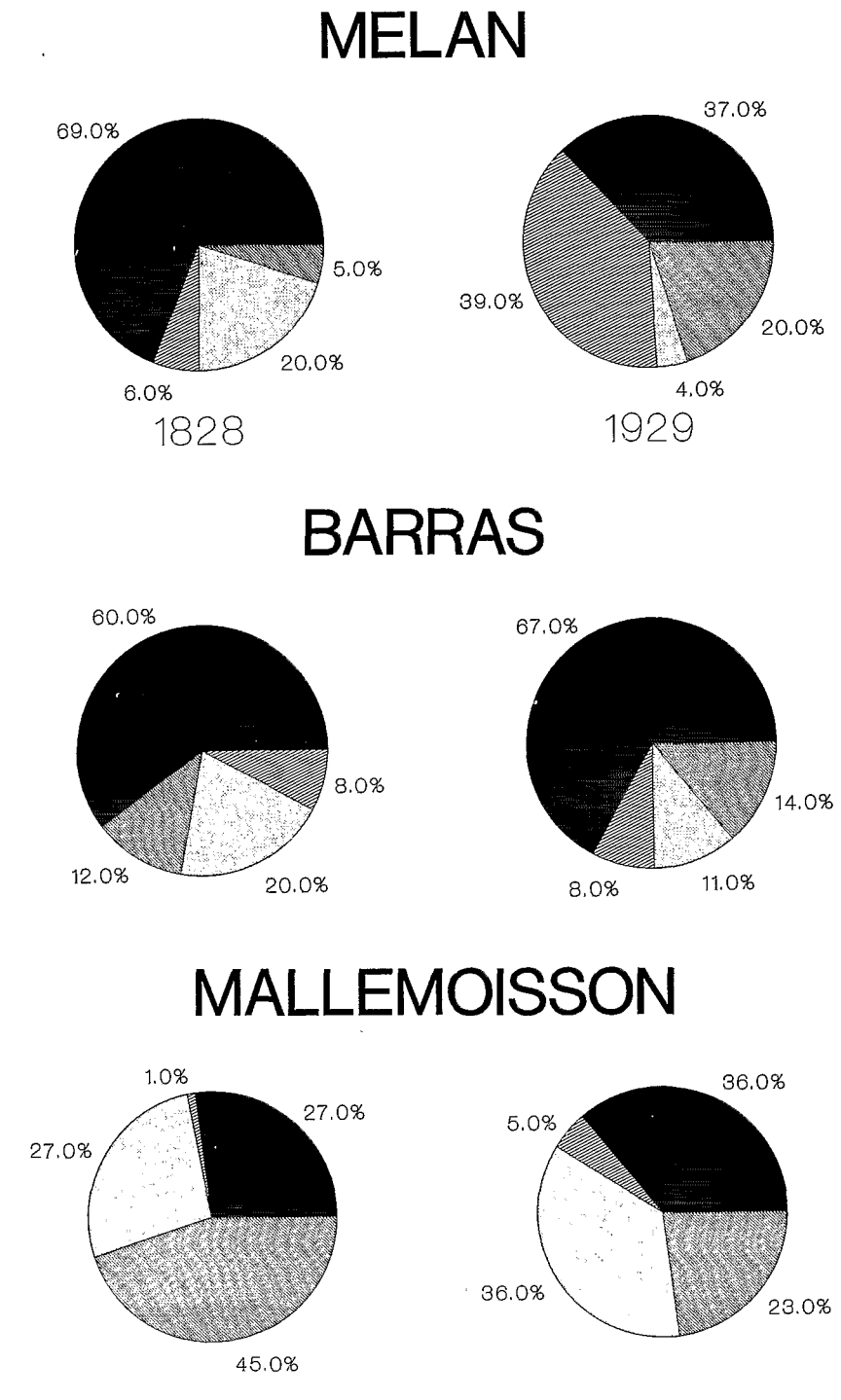


Fig. 8. Land occupation change in three village territories of the Vallée des Duyes (Alpes de Haute Provence) between 1828 and 1929 (from de Bonneval and Lachaux, 1987).

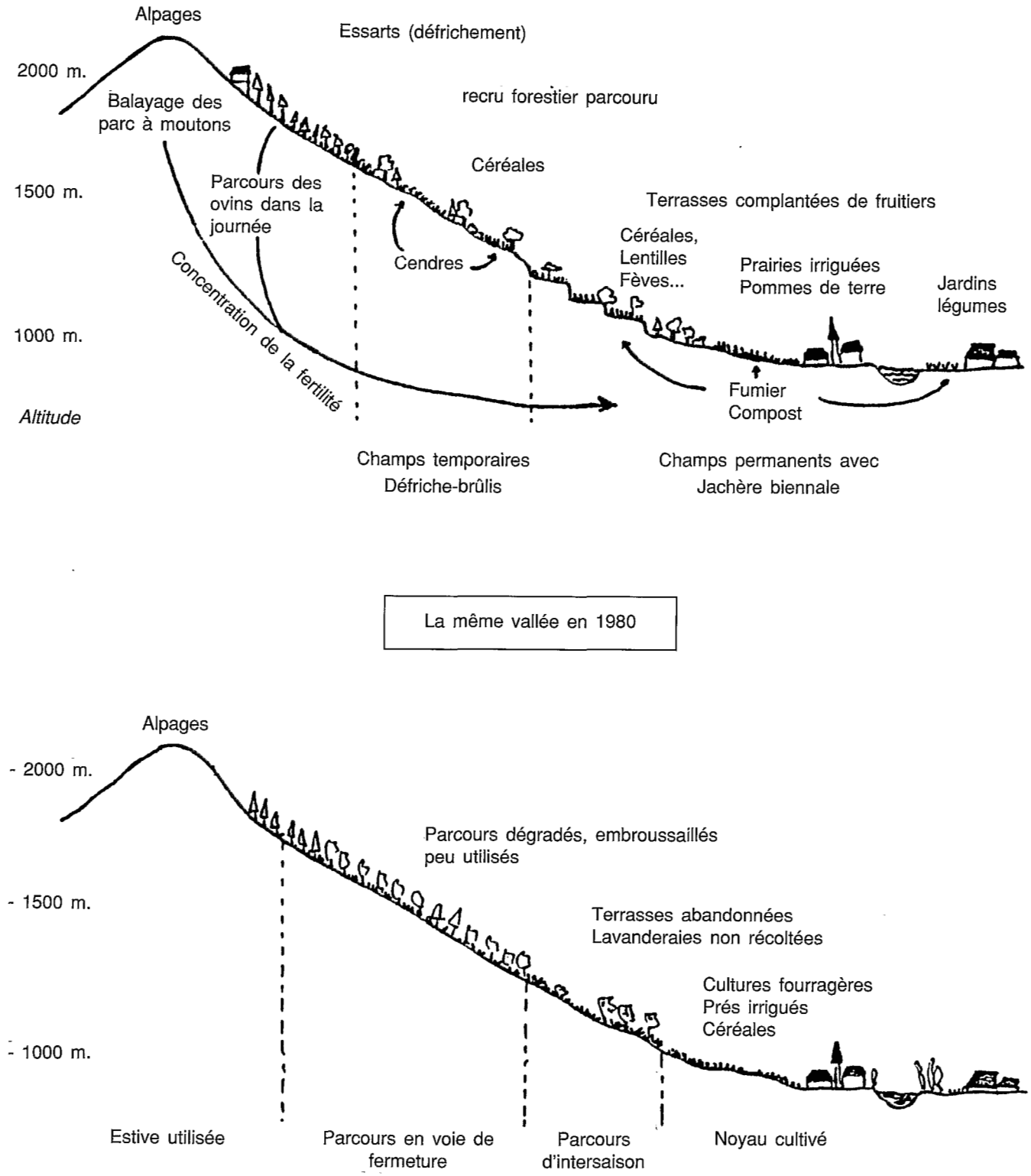


Fig. 9. Land occupation in the early XIXth century and nowadays in a Valley of the southern French Alpes (from Bazin, 1986).

Table 1: Evolution of the wooded area in the Var departement since the French Revolution (after Rinaudo, 1980).

YEAR	1789	1839	1873	1892	1911-13	1973	1985
Woodland (10^3/ha)	135	110	205	260	300	310	370
% total land in the department*	18	15	34.1	43.5	51	62	–

* The area of the department changed with the creation of the Alpes Maritimes department.

Application of this legislation in Mediterranean mountains went through a delicate phase until the 1914-18 war, with contradictory periods depending on the social and political forces of the time. The direct and indirect effects of the war on population after the development of a market economy and endogenous and exogenous crisis mentioned above opened up new scope for the reforestation policy, greatly aided by rural exodus. In parallel, the massive importing of tropical wood and timber from Scandinavia led to the developing of processing technology. The corollary was on the one hand the development of technology for the use of large boles and hence the under-use of the other products (used for making paper paste) and on the other the marginalisation of part of the forest considered - often rightly - as "protection" but frequently without the development of sylviculture suited to this type of woodland (especially as regards Austrian black pine and cedar, less for larch).

The progressive abandoning of much rangeland and cultivated land permitted the extension of the most pioneer woodland trees such as *Pinus sylvestris* at the edges of stands, thus giving the impression of a forest gaining on the area occupied by man. The percentage of wooded land in the Var department increased by over 20% (60,000 ha) in 10 years (1975-85).

2. Increasingly extensive land use

In the Limousin, for example, depopulation resulted in the departure of landless and small farmers. The large metairies, where all accumulation had concentrated on increasing land area, concentrated on fully open pasture sheep farming to produce lambs, with extensive use of natural prairies and much moorland ("brandes") requiring very little labour. The number of head of sheep increased five-fold between the beginning and the second half of the 20th century, whereas the population decreased. This desertification nevertheless enabled a few migrant farmers to settle on small farms with "modern" production systems combining sheep and cereals or cattle husbandry for meat production (Jean, 1986). The "empty spaces" were filled by spontaneous growth of Scot pine and a number of reforestation projects encouraged by the policy of the National Forestry Fund (*Fonds Forestier National*) after the Second World War.

Agro-sylvo-pastoral patterns in Spain and Portugal remained practically unchanged for centuries until the second half of the 20th century, thanks to an extremely protectionist economic policy. They were even well developed during the 19th century. Shepherds and forestry workers were plentiful and not fussy in a very hierarchic system, with the land belonging to the owners of large land estates (De los Llanos, 1987; Roux, 1987). In Portugal, the area of "*montado*" (cork and evergreen oaks) increased from 370,000 ha in 1877 to 1,300,000 ha in 1963!. Sudden economic liberalisation and industrial modernisation caused a considerable increase in wages (nearly 700% in Spain between 1958 and 1975!) and rapid price increase (competition from intensive pig farming, imported beef, etc.). Labour soon deserted the *dehesa* and *montado,* and not enough workers were left for traditional forest maintenance, for looking after flocks in woodland and for summer transhumance to cereal stubble fields.

Today, the farming systems are very extensive (100 to 150 ha per worker). Productivity is very low and less than mechanised grain farming for example (whence the clearing of oak in the Salamanca *dehesa*). The trend is towards new activities in which purchased animal feed and annual crops often play an important role: grazed beef herds in large fenced pastures, rearing of local pigs for high quality pork products, etc. In some cases, only gathering activities (cork) and hunting remain. These require little short-term maintenance and little development work. One might question the sustainability of such systems (continuous grazing, no pruning or tree replacement plan, low capital accumulation, low profitability of produce, etc.). Much land is abandoned or replanted with *eucalyptus*.

The consequences of marginalisation

The past century has been marked in the South of France by distinct specialisation of both farming systems and land. This has led to considerable marginalisation, at least of land. After a long period of continuous use in which it was taken to the limit of its production potential, some of the land is now used only for grazing a few flocks, for small-scale reforestation and most has a poorly defined social function (landscape, shooting land, mushroom picking) characterised by a land management gap (Fig. 10).

This land is subject to frequent fires. The average has been 35,000 ha per year in the 15 French Mediterranean departments over the past decade (with peaks at

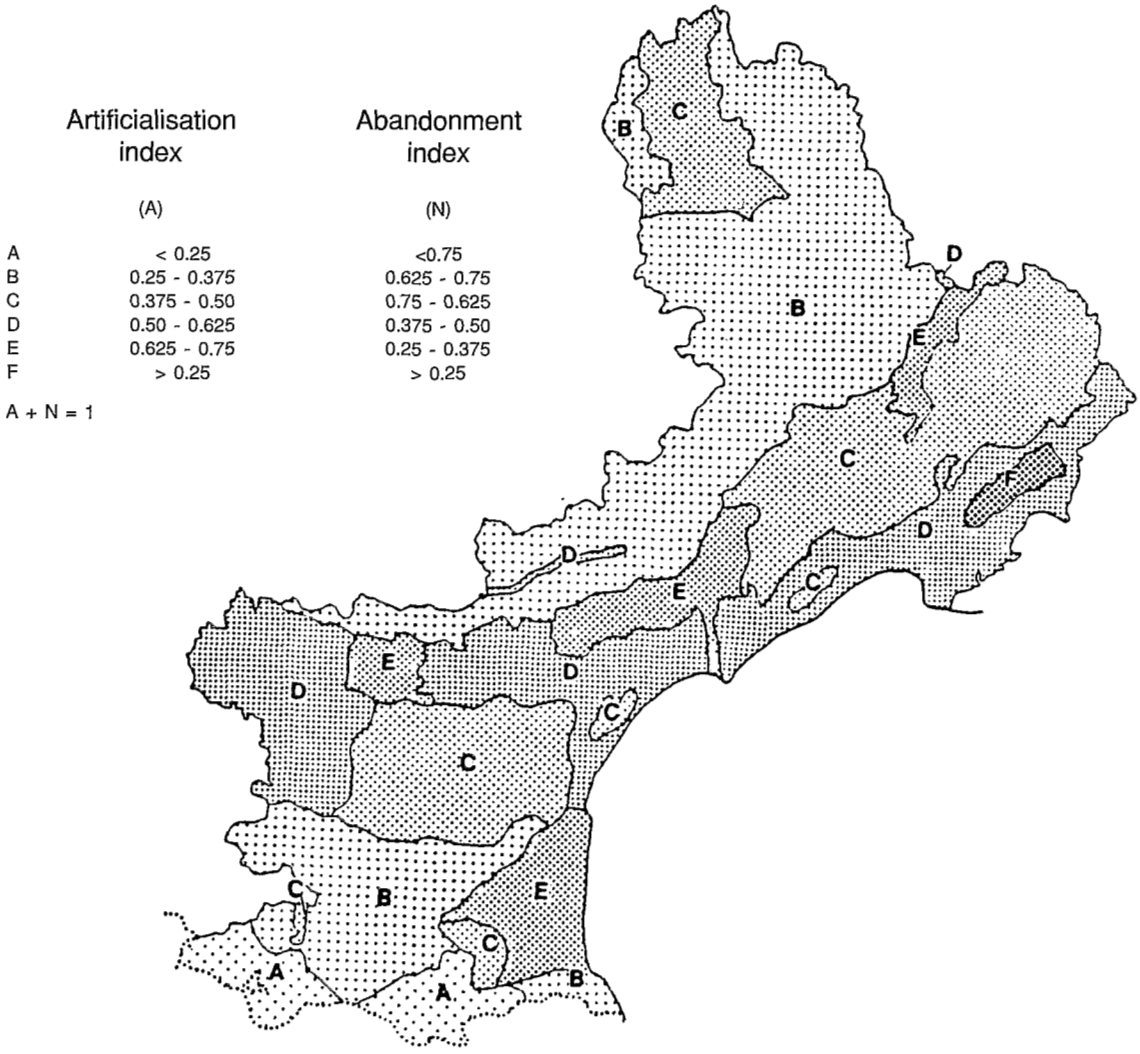


Fig. 10. Artificialisation vs abandonment of "ecological regions" in Languedoc-Roussillon, Mediterranean France. (Atlas du Languedoc-Roussillon, 1969, Univ. Paul Valery - CNRS-CEPE).

Zones A, B, C with an abandonment index > 0.5 consist of fallow lands, brush areas and natural extension of forests.

over 50,000 ha), i.e. 4% of the wooded area. In some department such as the Var, where the hills were among the first land abandoned because of the development of wine-growing in the middle of the 19th century, fires have affected 8000 to 10,000 ha each year since the 1860s (Faure, 1987). The former compartmentation of land has disappeared, enhanced by the abandoning of farmland, and recent fires have affected increasingly large areas. East of Marseilles, 13,000 hectares were burned in 18,000 fires between 1866 and 1870 against 20,000 hectares between 1961 and 1965 with only 1000 identified fires (Le Houerou, 1980); for the only year 1989, more than 50,000 ha with 4500 fires. I shall not cover here the ecological consequences of these fires which have been discussed by Le Houerou (1980 and 1981). It is simply reminded that "statistically" an individual hectare of French Mediterranean forest burns every 25 years!. The cost of prevention and fire-fighting is considerable in both financial (a thousand million francs a year) and social terms.

Specialised, mechanised and extremely productive agriculture has developed over the past thirty years: it is based on modern farming models and has benefited from strong rural exodus and a protected market for agricultural produce within the framework of Common Market structures and regulations. However, the 1970-1980 economic crisis led to a considerable increase in interest rates and the prices of inputs and in particular of feed, whether purchased or produced by the farmers themselves. The financial aid allocated enabled most farms to survive but frequently after a considerable increase

in the number of head of sheep, which led to renewed interest in the grazing land which was still usable and which had become necessary to complement inadequate cultivated forage resources.

How could this land be used profitably after the long period of decapitalisation?. As mentioned above, the grazing land has never been a specialised area and has never been the sole base for animal husbandry. Transformations should be envisaged with combinations of well-controlled cultivated areas and wooded or grassed rangeland. Tree cover has the advantage of maintaining a phenologically delayed grass resource during the summer dry season and may even provide rich concentrated feed (acorns and chestnuts) in autumn and early winter.

Innovative grazing sequences can thus be established combining prairie, natural grassland, moorland and woods with different species of trees (Guerin and Hubert, 1987) and forming part of a restructuring movement for the whole of the area in question. New development procedures must therefore be devised and the numerous achievements of ecological and pasture research in recent years used in grazing improvement in the broad sense of the term.

This abandoned land is obviously not always usable. Zones are often blocked by land holding problems of joint possession or subdivision or even by speculation in tourist areas (mountain and coastal areas and also increasingly in inland areas). The application of legal procedures for re-establishing cultivation is cumbersome and rarely used.

In addition, the French Mediterranean forest poses management problems for foresters. Nobody is really sure of what to do with aging evergreen oak coppice. Plantations of soft wood are promising for timber but sylviculture practices remain to be perfected and the permanent fire risk is hardly an incitement for innovation and large-scale investment. The fire risk is made even more acute by the fact that the stands are extensive and homogeneous. Some foresters, like Delabraze (1987), have therefore proposed the restructuring of the stands in a varied grid system with mixed areas required for their development and protection.

This is why, as was reminded by Hubert and Guerin (1987), a whole new balance is to be elaborated for continuous production and for management of the whole area but without costly specialisation. This new development of the land cannot be based on animal husbandry alone. Forest (wood) plays a large role. Other participants can also contribute to specific projects, but it is obvious that animal husbandry and forestry are the activities which can handle the largest areas.

Today, these crystalise appropriation conflicts. Foresters can easily stress the protection of the environment necessary. Livestock breeders can only demand more land (relative lack of good land, no control of rangeland). Private owners are generally noteworthy for their absence and demands are made mainly to communal or estate forests. A guiding role on the part of the state is conceivable but it would only have an effect if the effects could be extended to the three-quarters of the wooded land which is in private hands!

These dynamics are found in the zoning documents drawn up from scale of grazing or forestry potential (cf. most agriculture-forestry zonings which finally only report on the state of a conflict). It is relevant to note that the various groups concerned, in fact, analyse the environment in the same way: specialisation lays stress on productivity, in other words, soils are ranked according to their topography, depth and overall "fertility".

Finally, both operations are in difficulty (increasing cost of extensive growing of grass in comparison with grassland areas) and foresters who concentrate first of all on protection, have a slender chance of success either because the land is not very productive or because of the danger of fire.

Fighting this marginalisation, which too often today takes the form of the compensation of handicaps, makes it necessary to wonder, at a technical level, about other production methods. In fact, in the field there are farming systems which use their rangeland (meat production, wood and fruit, etc.). What lessons can be drawn from them? What innovation can be proposed and what economic and social organisation can support these activities?

Attribute functions to a variety of types of land

The future of the Mediterranean land depends on what rural societies are capable of devising to give it new functions which are coherent with 21st century cultural, technical and socioeconomic requirements. The compartmentalisation which has become set up over the past 100 years must be broken to establish economic and ecological management based on multiple uses.

After intense work and considerable transfer from the largest proportion of the land to the smallest (Fig. 11A), followed by a period in which practically only the latter attracted any attention, with considerable demand for multiple inputs (Fig. 11B), more evenly distributed capital and labour should be applied to make the most of combined, diversified production (Fig. 11C).

History has taught us that the ecological complexity of the Mediterranean environments makes their use delicate (and there has been considerable temptation to make them the same as models from elsewhere), but means

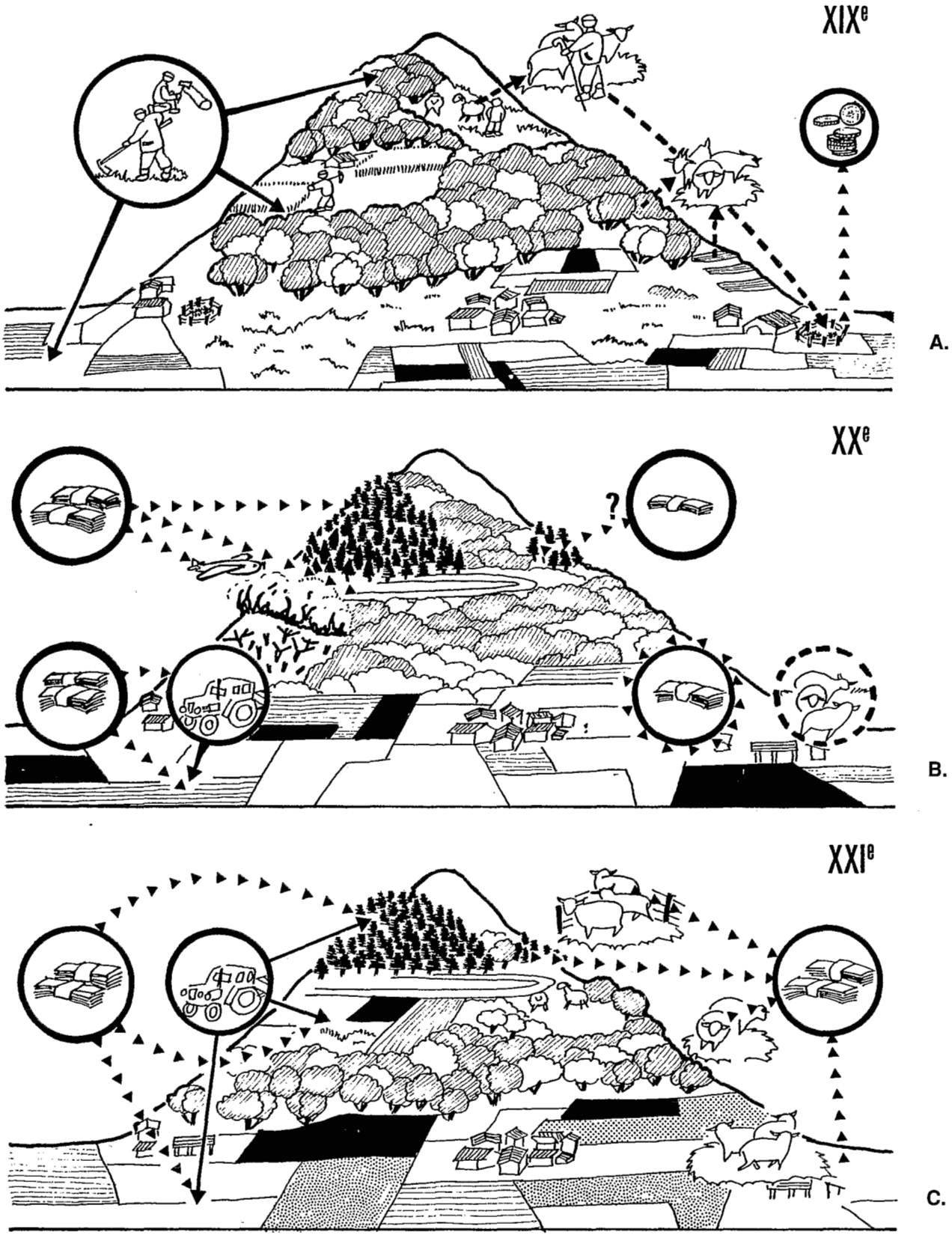


Fig. 11. Simplified diagram showing the distribution of production factors in a local agrarian system in the XIXth century (closed, self-supporting), in the XXth (open, separate) and a scenario for the future (open, self-supporting).

a great advantage in the situation of incertitude which characterises the present relations of society with its environments. The diversity of environments should be turned to profit and conserved by diversifying the farming systems concerned: several types of activity should be combined to suit local conditions (environment, market, technical potential, etc.).

Discussing the question in terms of extensive or intensive farming becomes very relative, as is reminded by Tirel (1987). What could be more intensive than the agro-sylvo-pastoral activities at the beginning of the 19th century (stressed by Kunholz-Lordat in 1945) but without the capital created being invested on the spot but sent far away or limited to only part of the land. What could be more intensive than the 20th century farming systems which poured capital and labour into so little land, but which heavily marginalised the abandoned land? What new relations can be envisaged today to fulfill better relations between land, capital and labour in the context of the Mediterranean today? What role can be played by herbivores in such a project? A few ideas on lines of approach are discussed in the following chapters.

II - Practices at the interface between ecological systems and social systems

Practices: a subject for research

We have thus examined the transformations of the rural landscape in the light of the evolution of production techniques and their effects on the control of ecological dynamics in the context of the economic and social events experienced by our rural societies over a period of rather more than a century. It can be considered that there is a spatial eco-socio-system made up of two interacting systems:

- a "resource environment" subsystem consisting of dynamic ecological or agro-ecological systems which become transformed by their own ontogenesis but also by changes in the environment (climate, geomorphogenesis), by farming and the management practices of their "resource" function by the local rural society;

- a "social" subsystem which is also dynamic under the effect of the evolution of societies and the changes in the relations between them and the environment.

There are many interactions of several kinds between these two systems. However, from the point of view of research in agronomy, it can be considered that they consist mainly of farming practices. The latter change by the simple evolution of the two subsystems of which they form the hinge. They receive innovations and are hence at the source of changes in the interactions that they materialise.

The practices of the people involved thus seem of central importance in the investigation of changes in the rural world. Taking them into consideration leads to revising some of our descriptions of the processes involved if the hypothesis is accepted that these practices can become a "subject for study" within the framework of research which would lead to pertinent knowledge for action. The people involved would be considered to act with a certain degree of rationality and not just apply the "recipes" which may be provided from outside. Without going as far as the study of the performance of these "actors", it is necessary to know at least how they take their decisions, what information they use and by means of what actions and for what objectives.

As has already been established by several research agronomists (Teissier, 1979; Milleville, 1987; Landais and Deffontaines, 1988), farmers' practices can be considered as objects for research; they differ from techniques to the extent that "although techniques can be described independently of the farmer who uses them, the same does not apply to practices, which are related to the operator and to the conditions under which he does his job". It can thus perhaps be said that although techniques are in the domain of knowledge, practices are in the domain of action (Deffontaines and Petit, 1985).

Livestock farmers' "ways of doing things" can be observed and investigated by direct survey or interview. They can even be evaluated and characterised from different points of view: the mode of operation (what does the farmer do and how does he do it?), their effectiveness (what are the results of this action?) and their appropriateness (why does he do it?) (Landais, 1987). It would also be possible to identify the effect of a practice, which is measured on the objects directly concerned by the technical operations that it organises, the more or less far-reaching effects of the adoption of this practice (on the career of the animals, the dynamics of plant growth, etc.).

Animal husbandry practices based on forage systems which create and profit from diversity

1. Production depending on the dominant economic processes

Even if Mediterranean animal husbandry units, which use natural areas, may stand out by their original type of production or by quality, they are nevertheless subjected to market rules and constraints over which they have little control (national or community policies, competition from other regions, eating habits, etc.) The type of product is often defined as relatively independent of the specific "potential" of production and the farmer must adjust his flock management to these production

choices. He must pay all the more attention since the inertia of herbivores is much greater than that of monogastric livestock (pigs, poultry, etc.). The farmer must handle a compromise between production oriented towards acceptable commercial objectives and the constraints of flock management: adjustment of the requirements thus created and the resources available in the various areas that he can use.

Until recently, the dominant development models oriented farm structures towards land clearing and the extension of land which can be farmed by machine with large consumption of capital (purchases, operations, etc.). The economic difficulties experienced at least in sheep farming (debt, low flock and labour productivity, cf. Boutonnet and Martinand, 1979) caused a change in orientation towards livestock systems using much more varied resources, including "natural" areas (rangeland and forest).

2. Varied production systems

The main domestic herbivores may thus be involved:

- horses: breeding of mares of heavy races but whose development is very limited in France because of the economic difficulties of the "horse meat" sector; wintering of trek horses, etc.

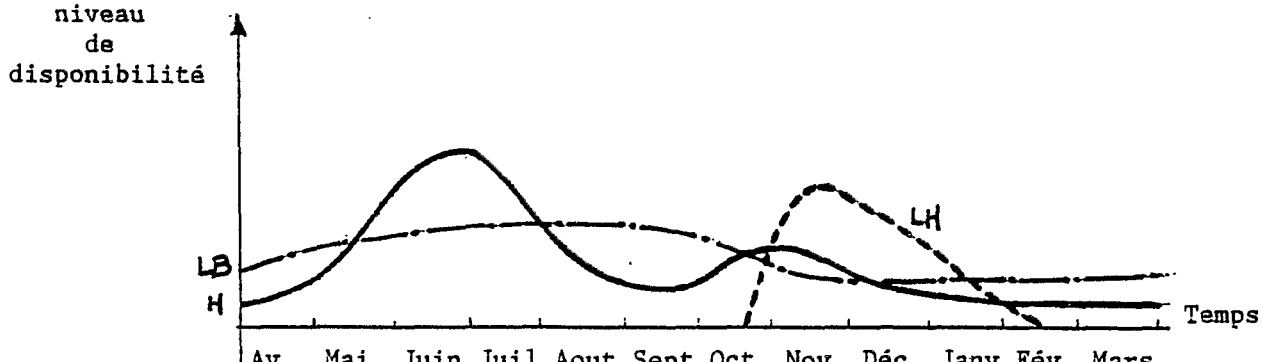
- cattle: milk or meat races in livestock systems based in mountain areas and which seek areas to winter young cattle to economise the winter reserves intended for adult animals (e.g. milk cows).

- goats: mainly specialised dairy races or sometimes local mixed purpose races whose "meat" production remains to be defined commercially.

- sheep: ewes for producing 15 to 17 kg lambs, generally bred or finished in the sheep-fold. There are transhumance systems combining alpine grazing in the summer and grazing in the plains of Lower Provence in the winter, and more sedentary systems.

3. The adjustment of requirements and resources

The requirements of the flock are defined according to the production cycle and hence vary during the year. The aim of the forage system is to cover these requirements as best as possible given the resources available. Production of the latter varies in quantity and quality and in time (Fig. 12) according to the areas concerned. The breeder must therefore make adjustments between these variations and those of the requirements of his flock and possibly use fodder from outside (hay, silage, concentrated feed, etc.).



	Printemps	Eté	Automne	Hiver
H=tapis herbacé	++++++	++	+++	+
LB=broussailles	+++	+++	++	++
LH= arbres	0	0	++++	++
TOTAL VEGETATION	9 +	5 +	9 +	5 +

Fig. 12. Forage availability in a chestnut woodland (from Guerin and Ostermann, 1986).

These are complex forage systems based on the matching of two fields of variation: the requirements of the flock and seasonal aspect of the resources. They are based on a set of biotechnical factors which the farmers incorporate in their practices:

- animals: the food requirements for mating, for the end of pregnancy and the beginning of lactation, the flexibility of livestock with regard to maintenance, the possibility of compensatory growth, the accumulation and use of body reserves,

- plants: the use of standing forage carry-overs and ligneous resources, delayed growth at high altitudes and on certain slopes, production of acorns and chestnuts in the autumn, the quality of the grass before it comes into ear, early or late varieties, etc.

There is thus a "pasture grazing sequence" which in these systems usually combines areas at different altitudes and production quality: seeded pasture, improved natural pasture, poor rangeland, grassland with trees, tree fruits, etc.

4. A representation to show the functioning of the grazing system

"Functions" can therefore be identified in the organisation of this grazing system, as proposed by Guerin and Bellon, (1989). The Figure 13 thus shows that 9 different functions can be identified in dairy goat breeding units in the South of France. Each expresses both the use of land, a period in the physiological cycle of the animals and a phase in the flock complementation strategy.

Part of the territory concerned (which may consist of one or more plots or grazing units) can be identified for each function, together with a mode of exploitation of the resources, i.e. "the sequence of use over the year and the amount of forage used during each grazing period." (Guerin and Bellon, 1989). The latter authors identified three modes according to how the resources are used by the flock: "forage", "sorting" and "management". These correspond to distinct objectives (for both the resources and the livestock), i.e. respectively to (i) ensure maximum consumption of forage; (ii) to increase the quality of the ration and to enable the animals to choose, (iii) to limit brush growth and to ensure the sustaining of the grass.

The means to be used are different to obtain the effect expected and to control the consequences; the latter point may lead to combining in time different operating methods in the same plot.

A landscape structured and organised by the practices of the different people involved

We can thus visualise and understand how livestock farming practices "organise" the area that they cover. We can attempt to devise tools equivalent to those described above in order to understand the organisation in space and time of the actions of the other people principally involved, such as foresters and hunters. The former are concerned with forestry development and its implementation by management plans which form the basis of this organisation. The greater proportion of study of hunting practices and their consequences for the use of territory remains to be carried out. Such an approach should make it possible to investigate the traditional conflicts between hunters and other users of the territory from a fresh viewpoint.

We can thus consider that the combination (synergy or conflict) of the practices of the various people concerned in a territory - each group with its own objectives - produces an organisation which is self-regulatory and governs the landscape structure at a given moment. The groups, e.g. farmers and foresters, can have a considerable effect on the biological material or, on the other hand, through regulations, development procedures or even the mobilising of funds, as can certain institutions (agricultural services, national parks, etc.) or their cultural and symbolic representations such as hunters and certain walkers, etc.

It has been seen that these dynamics are not synchronous. Social and technical changes can occur rapidly. Ecological evolution follows its course but can also be considerably disturbed or even changed by certain practices (cutting of coppice, fires, etc.). Today, in the Mediterranean region, we have inherited a plant landscape which is the product of the obsolescence of preceding rural societies. We do not know how to master plant dynamics on their spatial level, given our techniques and our present means of intervention. The malfunctioning of our relationship with the environment is shown by the increase in the risk of fire. What should we do? How can we question the present organisation and make another emerge whereas this does not depend either on a single group of people or on an infallible authority?

III - The creation of new functions and new information

Creating new functions, e.g. such as protection, amenities, etc. (in addition to the more usual production functions) can lead to reconsidering the objectives of all the groups. This situation can occur when there is a strong local volunteer spirit, where a recognised collective

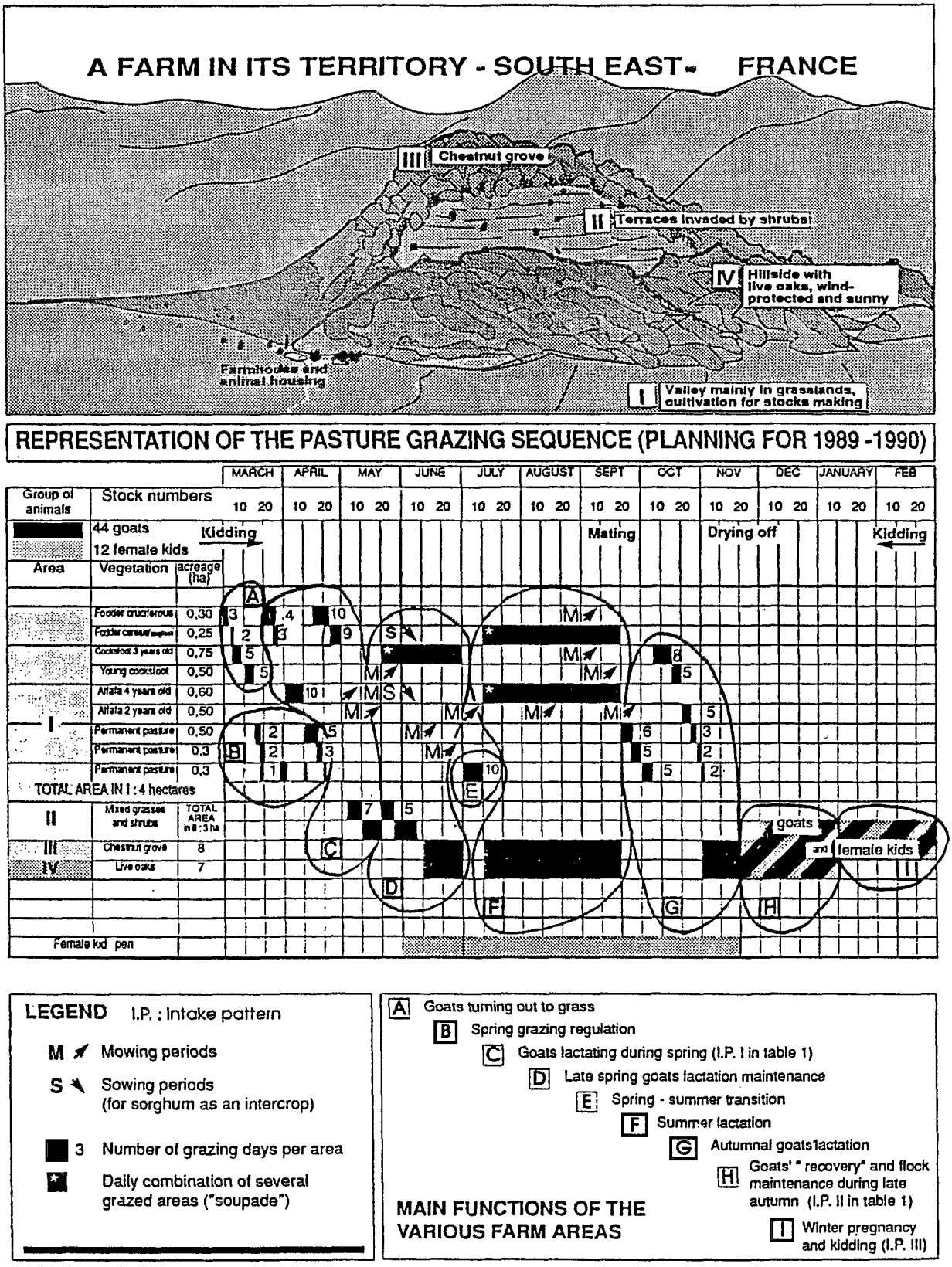


Fig. 13. An exemple of graphic representation of the pasture grazing sequence in a goat farm in south eastern France (from Guerin and Bellon, 1989).

project is accepted, or more frequently after a destabilising event such as a large forest fire.

This can be the occasion for questioning the objectives of the main groups involved within a new formulation of their performances. This requires different organisation of information, or more frequently the creation of new information.

The concept of development by diversity has emerged from reflection by Mediterranean foresters, starting from the observation that the homogeneity of the environment enhances the propagation of fires and makes it more difficult to control them.

The first idea consists of the creation of a network of firebreaks which would "roughen" the landscape and form a grid of forest formations. Recent regulations (1981 ministerial memorandum) thus allow the clearance of 20% of forest land. This can either be in the form of linear firebreaks or more complex systems with clearing matched to the terrain as best as possible and where the layouts are of varying shapes according to the field conditions.

However, some foresters, such as Delabraze (1987), consider that the Mediterranean forest should be developed with optimisation of its variety: the juxtaposition of plots of different species, different ages, cleared plots and open spaces and then others very densely planted in mosaic or checkerboard layouts to achieve heterogeneity which takes into account the diversity of the soil and climate characteristics. He considered that these conditions are necessary to reconstitute a Mediterranean zone with maximum guarantees of protection against fire.

The hinging in space and time of this organisation of the diversity of plant forms stemming from a forest development plan and that required for feeding animals in all seasons in accordance with their varying requirements is the very basis of the concept of sylvopastoral development.

Mastery of this integration and the situation in the different seasons over the years is one of the keys to production and to the sustainability of this sylvopastoral system and to the protection to the whole of the forest area. Within this framework, the use made of the various plots changes with time according to plant dynamics and the "functions" expected of them. Likewise, animal husbandry can use a range of plots different according to the seasons and adapt this use to pluri-annual changes.

Sylvo-pastoral systems: combining zones in time

New land management practices will therefore emerge based on the exploitation of forage or ligneous resources organised in space and time by two hinged, partly overlapping systems, each with different objectives at least as regards production (Fig. 14). This organisation is expressed in time, as was reminded by Hubert *et al.*, (1989):

"- on the scale of the year. This means achieving a pasture grazing sequence which must combine all the space available, combining diversity of resources and of grazing management methods. Low-productivity areas will thus form part of the whole and be used when flock requirements permit or with certain conditions of grazing. Likewise, critical periods can be covered thanks to appropriate management methods which allow the animals to choose or thanks to better resources from classic grassland (if possible) or after work on other environments (fertilisation of wooded rangeland, planting of trees or forage shrubs, oversowing with forage plants, etc.

Foresters also organise, on an annual basis, the various jobs to be carried out and therefore distribute labour costs and if possible the exploitation and sale of production.

- over a longer period of time, forest management "the implementation of development of the forests" modifies the environments available on a large time scale (20 to 100 years): plantation, enrichment, thinning, sowing cut, full cut, regeneration cutting, conversion of coppice to high forest, etc. The structure and morphology of each plot of forest will therefore vary according to the management plan used, i.e. the structure of the grazing chain of a flock using the forage species in such a forest which be considerably changed over the year according to the changes in the plants concerned.

It must thus be remembered that forage resources must be maintained for the whole of the species concerned when sylvopastoral development is planned.

Thus time, the traditional site for lack of understanding between grazers and foresters when each thinks separately, will become an essential dimension of development on which will be based "at different combined scales" the organisation and control of plant dynamics in space, since it is by playing on differentials in growth and in exploitation rates of the various strata (and their interactions) that a varied, structured landscape can be maintained and constructed."

New practices possible through the creation of information

These new methods of management of space will stem from the transformation of the practices of the groups concerned, that is to say that they will act differently using a new information system which is pertinent with regard to their objectives. Concepts such as drawing

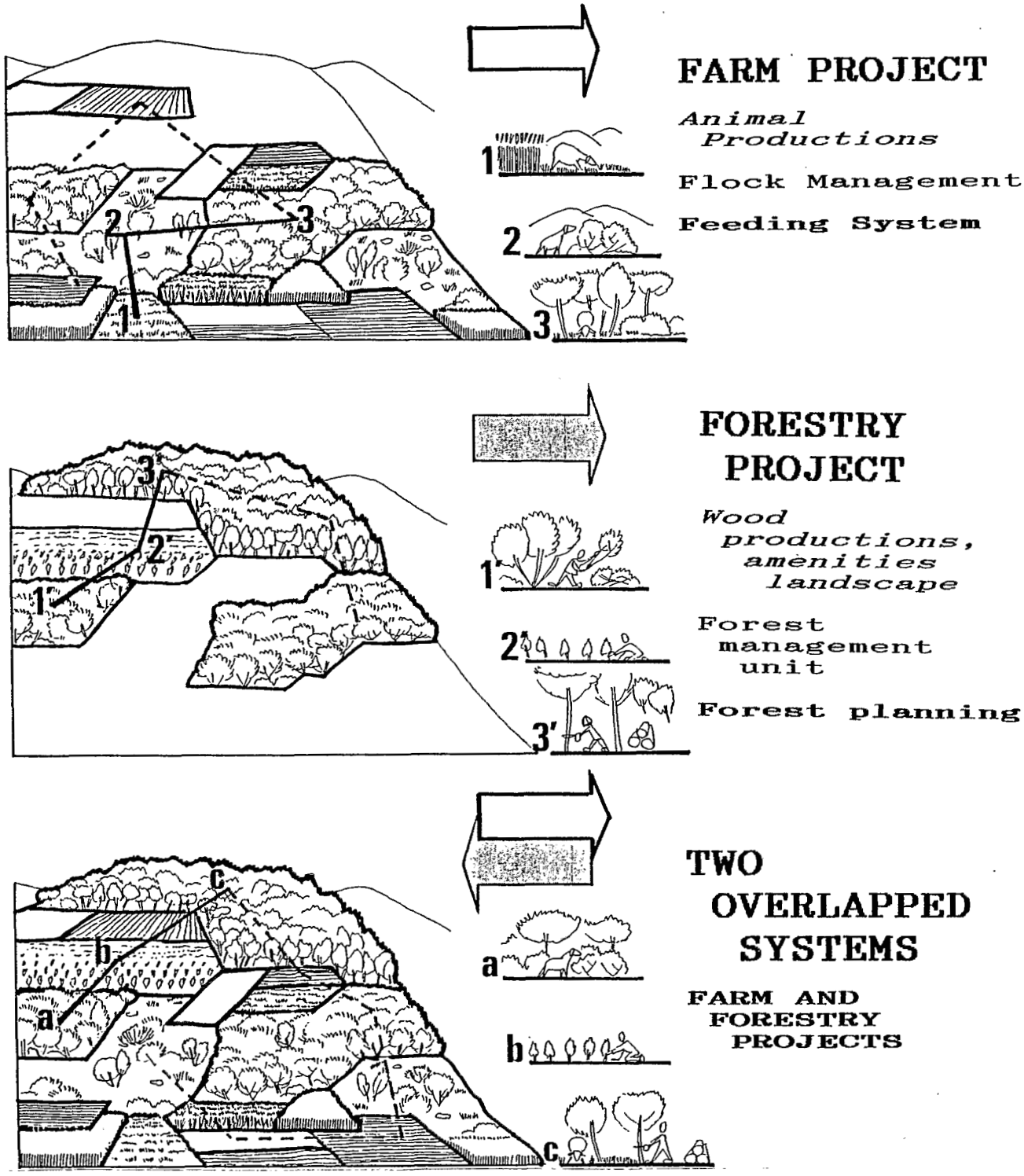


Fig. 14. A sylvopastoral system results from two overlapping systems: an animal husbandry project and a forest one; both organise the different parts of the territory according to their aims, their technical constraints and the internal consistency of their own system.

added value from diversity from the point of view of the organisation of the pasture grazing sequence or the development of a fire risk will use new information such as:

- identification of the functions of the various parts of the territory of a holding in the design of a pasture grazing sequence,

- the technical procedures required for carrying out these functions,

- the effectiveness of such a technique or combination of techniques for the control of forest understory.

Research will be carried out, for example, on the grazing procedures for different types of plant growth, on the value of the forage, on suitable complementary feed, the behaviour of animals in different situations, the potential for the improvement of forage production (grass, shrub foliage, fruits), the possibility of the transformation of multi-story growth into grassland with trees, thinning procedures for various types of ligneous populations, etc.

In such organisation, research serves as much to help to create this information as to formulate questions which arise so that the groups of people concerned can take decisions with reference to clear statement of the problems. An interactive system will thus be set up for the circulation of information among the various people involved, including researchers, aimed at producing new operational concepts and supplying them with pertinent knowledge.

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