

## Functional aspects of mediterranean mixed farming systems

Pedro Montserrat Recoder  
Pyrenees Centre of Experimental Biology  
Jaca (Huesca) Spain

### Summary

Ecology of systems gives one an intuitive insight into the evolutionary trend of Mediterranean farms when faced with the ever increasing costs of energy for heating, and prohibitive labour costs which are leading to the gradual disappearance of that traditional regulator, the shepherd.

It is becoming more necessary to use "animal labour", controlling the herd so that it produces its own pasture. Regulation of grassland will be seen to be facilitated by the use of hedges with trees which will give an agreeable environment to the animals while at the same time contributing to their sustenance (almond, fig, olive, elm, lotus, etc.) The hedges referred to give a minimum structure to assure dynamic stability, permitting a progressive capitalisation to localise the fertility of the soil on the surface. Pasture is very demanding in superficial fertility and the production of sheep, the essential Mediterranean animal, depends fundamentally on the humus accumulated, especially that created by animal excrement.

### Introduction

We have been trying to understand and expound the basic principles which control not only the productive processes but the stability of the agrobiosystem. (2), (3) and (4) since 1961.

A very high number of precedents, including a study of the interaction between grazing and animal, lead us to what we call livestock farming, which is to a certain extent opposed to the traditional type or crop-farming.

Now is the best time for extending the techniques of exploiting the soil without actually cultivating, techniques which would cost very little, and which would be based on the functioning of certain biological devices which operate by solar energy, thus being free of the high international cost of more traditional fuels.

Modern technological development has had a great effect upon cultivation techniques, leaving behind traditional livestock farming which has survived into the present age with marked characteristics of archaic non-intensive exploitation.

The great mistake, in Mediterranean lands, of continual ploughing of soils which are little suited to the practice, is obvious. It is no less certain that the abuse of grazing land, uncontrolled fires for example, caused even greater problems, thus accentuating endemic erosion. Man has always abused his environment, subjecting it to actions more appropriate to the realisation accumulated capital rather than gradually improving productivity of soils and pasture.

We shall briefly look at some aspects of livestock farming which permit of capitalising, that is increasing the productive capacity of the mixed farm without destroying it. Current ecological theory permits of a scientific approach to the aspects related to the stock system, activating production without recourse to the drastic oversimplification of fire and tilling the soil (artigueo).

### Exploitation of the ecological system

All diversified and productive ecological systems tend to become more complicated in time because of phenomena of their internal organization: diversity of structures and functions with a ceiling imposed by usable energy, availability of

materials, and especially evolutionary history in an area with little fluctuation, or with cyclic rhythms which are foreseeable from the mechanisms of genetic selection.

We ecologists consider that the environmental factors can be "abiotic" (soil, climate) or "biotic"; this is the total number of factors which influence each component of an ecological system. For any plant in grassland the environment created by the animals using the land is very important as is the environment created by hedges and tress, but especially important is that created by man, who in his cultural resources indirectly acts upon it.

This environment can exploit plants and animals, thus impeding that indefinite progression towards the maximum complication of the mature community. It is a question of reducing biological mass, which in turn releases stored fertility, thus making it possible to extract products needed by men. A good method of exploitation displaces the balance of the mature community (in our case an oak forest) towards a herbaceous community which can be exploited grazing land and which is stabilised around a certain level of exploitation.

It must be understood that in order to maintain this degree of exploitation it is necessary to have the ideal natural fertilising mechanisms available. The livestock pasture subsystem predates man, developing over millions of years, and has a very efficient fertilising mechanism which it is useful to understand well and complement efficiently. (6) Ploughing rapidly releases retained or stored fertility, but also destroys important structures, reducing the capacity for auto-regulation.

Let it be quite clear that when we say exploitation we mean the breaking down of animal or vegetable matter, releasing the necessary fertility in order to balance the part taken by man's needs. We have a system which is already adapted to exploitation, that is pasture, with a simplified vegetable structure, but which also has powers of regeneration (tillering capacity). Animals at grass also increased their rate of replacement pushed by a series of very diversified and active predators. Man substitutes these and increases the stated capacity for reproduction by selection.

### The soil/pasture subsystem

In a varied climate, with prolonged dry periods and abundant sunshine which raises the temperature of the soil to intolerable limits for the plants of a productive grassland, the fundamental subsystem is the soil, the true wealth of our farmers. It is safe to say that it is the soil which can least stand any form of simplification, and ploughing is often counter-productive because it is too drastic.

In any small valley we can see differing levels of the soil with a more or less permanent ground water table towards the deepest part; very different potentials which make for diversity of pasture which thus increase the versatility of the system as a whole. The lower parts, too, receive water and fertilisation laterally, whereas in the higher parts, rainwater tends to wash away the topsoils, leaving the ground impoverished.

To the physical mechanisms of fertilisation already mentioned, there is added an extraction of great fertility from the plants and trees with powerful roots. It is understood that plants and shrubs are an essential part of the higher slopes of any hillside; without them we suffer erosion, which ruins the soil both chemically and physically. In glacia and at the foot of mountains the watering and fertilising systems are much better because of the supplies reach them from higher up. Said

possibilities are greatest in the soils of the lower slopes, and especially where there is a freatic flood water which joins up with the already mentioned coluvial.

The Mediterranean climate accentuates the difference between sunny areas and shady areas, thus contributing to the diversity and stability of the cattle system by providing a greater variety of pasture.

The pasture more extensively used consists of plants with shallow roots, and this means the problem of under-using the capital base which is our soil. It becomes necessary to alternate turf-rooted ones, generally shrubs or trees; thus vegetable and animal fertilisation is limited, being deposited on the surface compost, and favouring more productive grass, exploited with greater intensity, and for this reason not very apparent.

The protective vegetable structure, the trees and shrubs of the hedges, drains heavily on deeply sited nutritive elements although they maintain structures that recycle very slowly, storing potential fertility abstracted temporarily from the animal/pasture cycle. Then the browsing animals (e.g. goats) intervene, and this accelerates reincorporation into the trophic cycle. Generally, all herbivores act in this accelerating way upon the trophic cycle, and, besides, laterally transmit fertility to certain places, which tendency we can modify.

The greater the adversity of the climate, then the greater will be the strain placed upon protective vegetable structures, with deep roots, to get the most out of the control potential of the soil, but without suffocating the plants with shallow roots which are more productive in favourable conditions.

### Reticular structures

The general principles just discussed lead us to consider briefly the ideas so masterfully expressed by Margalef (1) on discriminate, varied exploitation, with very potent simplified areas surrounded by others of greater structure, efficient but with less production per unit of biological mass and time. These are networks of both space and time, which increase ecotonic surfaces favouring interchanges and maintaining the stability of the whole.

In a Mediterranean climate we do not conceive of a homogeneous pasture, continuous and very extensive, for there soon appear shrubs and rough coarse esparto types grasses (*Stipa tenacissima*, *Lygeum spartum*, etc.) with deep roots among which also appear little patches with attraction for the animals. The trees and shrubs indicate the tendency of the soil to form sclerophyc forest, a vegetal community which is very good for taking advantage of the rains of the cold months and for resisting the summer droughts by a strong insulation which warms the soil.

Thus there appears a neat structural model ideal for the harmonious working of the whole, with trees and protective shrubs among which the most productive pasture can grow in the conditions stated. To my mind it is a cerebroid network with multiple contact between trees, shrubs and pasture, with high hedges to separate units of grazing for each type of stock. A biological structure completed by an industrial structure, both very natural, make it perfectly possible to regulate stock capacity and to give the animals suitable surroundings both for rumination and for quiet repose.

### Diversification of livestock

Domestic herbivorous animals do not behave in the same

way as the animals which browse, that is, goats, equines, and indigenous breeds of cattle from among those that graze.

The browsing animals chosen for this function will be absolutely fundamental, as we have seen that they accelerate the reincorporation of stored fertility in the protective structures and they also slow down the invasion of the grassland by the hedges surrounding it. These browsing animals will also eliminate the danger of fire, which is such a characteristic resource in Mediterranean lands and the factor which has contributed more than any other to the degradation of our countryside.

In order that this browsing should work efficiently it will be necessary to select the shrubs and trees forming the hedges with care, favouring those species preferred by the animals and ignoring those which may be poisonous, or which are not very attractive to the animals, we are now on the threshold of a new type of farming, the farming of the hedge, which is very closely linked to the cattle farming of the future. Among the Mediterranean shrubs and trees we could mention are the olive, the almond, vines, oaks, the "olivillo" (*Phyllires*), the "retama" (*R. sphaerocarpa*), figs, the lotus, gall-oaks etc. The field of research is enormous, and very promising.

The various breeds of sheep form the fundamental Mediterranean livestock structure; these profit from a turf which is more or less permanent, and which can resist teeth, tongues and trampling. There are many species of sheep with quite varied ethologies; in addition the breaking down of flocks by age, sex, crossing etc., gives an acceptable, though not sufficient, variety of livestock.

Equine animals are fundamental in getting a slow-recycling structure moving, and especially asses and their crossbreeds with horses. At the end of the summer they eat dried grasses, especially those of *Brachypodium phoenicoides*, *B. ramosum*, *Agropyrum spp.* etc, which slow down the production of a finer pasture; besides they also browse a little, and can distribute fertility if we can manage to control them intelligently.

In Spain we have evolved certain species of cattle which can withstand the heat and which eat more common herbs found in Mediterranean pasture. Cattle and horses should create the pasture for the sheep and in many cases they are essential to maintain it.

This diversification of livestock demands high standards of care and attention which are not normally found among the majority of our farmers. We should try and attain this, however, as it is the only way of finding productive elements which will work for the enterprise, operate by solar energy and produce something, stabilising the whole operation.

### Stability in a difficult environment

Diversity (structures and functions) is a condition of stability if we want to adapt the system to more difficult environmental conditions. The danger lies in complex structures which can consume everything produced by the plants. The same complex vegetable structure breathes in relation to the biological mass, using, moreover the subterranean waters which are so necessary for the regulation of heat, and adequate chemical fertilisation.

Because of all this, diversification has a certain limit which varies with the environment; emergency watering can contribute towards maintaining adequate varied structures in each topo-

graphical environment. One certain fact is that future research will show very clearly indeed that it is best to keep vegetable structures in networks like those already mentioned. Species and standards will vary, but the said structural network will give stability to the whole, permitting intense exploitation over limited surfaces, spontaneously fertilised, and with a better local climate than in the corresponding topographical areas.

### Regional diversification

We can guess that part of the problems caused by a diversification of livestock in difficult conditions can be resolved by certain slightly specialised techniques, but within a structural network regional varied enterprises.

For example the farmer who has horses or donkeys is very different from the rest for it is necessary to have large areas of grazing land, and they must graze their stock over the grassland of a whole district or several districts; it calls for great mobility of livestock, and it would not be a good thing to stable it, so that it takes maximum advantage of the grazing not used by the sheep and cows, and we could say the same about goats in this case.

In wooded Mediterranean areas, especially near big game

reserves, deer create reticular structures in the forest, with pasture which could be used occasionally by an acclimatised flock of sheep. Game and farm animals complement each other quite frequently, and give a diverse animal structure of Mediterranean mountain lands.

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