EXTENSIFICATION OF GRASSLANDS IN EUROPE

A. Peeters[1]

[1]Laboratoire d'Ecologie des Prairies, UCL, Place Croix du Sud 5/1, 1348 Louvain-la-Neuve; Belgium

ABSTRACT

Extensification in Europe concerns more the land than the capital or labour. It consists of using more space and decreasing the inputs (fertilizers and concentrates). The stocking rate is reduced but individual animal performances must remain acceptable. In view to meeting this objective, various means can be considered: better valorization of roughages, renouncement of regular sowing of selected varieties, rational utilization of legumes, optimum use of animal manure, strategic N fertilization. Beneficial effects are expected from extensification: territory occupation and maintenance of landscapes, biodiversity conservation, quality products, pollution reduction and energy savings. However, these advantages are not observed in all cases. This depends on the way that extensification is achieved. In view to limiting the negative effects on revenue, the taxes charged per hectare by the states should be reduced. This will enable farm holdings to grow while diminishing their fixed and variable costs per hectare. Some policies, such as the CAP agri-environmental scheme and the PI programme in Switzerland, try to combine more tightly extensification, financial compensation for farmers and environmental benefit.

KEYWORDS

nitrogen, legume, white clover, stocking rate, slurry, farmyard manure, environment, biodiversity.

GENERAL BACKGROUND

Agricultural production has considerably increased in Europe in the second part of the 20th century. The grasslands yield and animal production have followed the same tendency. Regarding grasslands, N-P-K fertilizers and liming have highly contributed to these yield increases. However, the role played by better grassland management has been at least equally important. The finalization of rational pasture systems allowing control of the feeding value of grazed grass and the mowing of young fodder stored for silage has helped to considerably improve the fodder quality and therefore the animal performences involved. The varieties selection and the regular grasslands renewal have also undoubtedly contributed to perfect the yields and the forage quality but their influence has been less significant than fertilizers and management systems.

In the same time, farms have specialized themselves either in vegetal or in animal productions and the number of farmers has considerably decreased. The farms' size could then grow. The quick and regular yields increase has constituted a survival guarantee for the remaining farms. However, their revenue is still too low. In the European Union (EUR 12), it was about 12,500 ECU per year and per worker as far as dairy farmers were concerned and, regarding the other ruminant breeders, it amounted up to approximately 8,000 ECU in 1990/91 (CEC, 1993). However, big differences exist between regions. In the Netherlands, for example, the dairy farmers' revenue is about 25,000 ECU per worker whereas their Spanish colleagues only have approximately 5,700 ECU. In the future, the number of farmers will still be decreasing. In some countries, the proportion of the economically active population working in agriculture is about 2% (Belgium, Great-Britain) while being equal or higher than 20% in Poland, Rumania, Greece, ... The European average (apart from ex-USSR) is close to 9% (FAO, 1991).

These general processes of agriculture evolution and the progress achieved in the production methods have generated social and environmental problems.

Within a dynamic framework of employment development, as in the 60's, the excess agricultural manpower was absorbed by the other sectors. In a situation where few jobs are created, as is the case nowadays, the jobs cancelled in the agricultural sector come in addition to the other unemployed people. In some little populated regions, the number of farmers decreases to such a level that it does not allow the existence of other economic activities (little shops, schools,...). The social environment is being destroyed, these regions are becoming deserted (central part of France, ...).

The huge utilization of N fertilizers and of N-rich concentrates has highly increased pollution outside the agricultural system involving this element. This can be classified in 3 categories: the NO_3 leaching which enriches the water tables at such a level that the drinking water standards are overstepped; the NH_4^+ volatilization which contributes to the forests decay and to the degradation of oligotrophic-type ecosystems (peat bogs, heath lands, ...); the N_2 and N_2O denitrification, the latter contributing to the green house effect.

The quality of surface waters has also been degradated through the run-off of nitrogen and phosphorus. The high stocking rates in the valley bottoms have often involved either indirect pollution by NO_3 leaching under the meadow, close to the water course, or direct pollution by the animals access to the water course.

These high fertilizer dressings have also favoured the productive grasses at the expense of almost all the other plant species. This has led to a huge reduction of grasslands biodiversity. Other methods such as herbicide utilization, grasslands renovation and early cuttings have also interfered in this phenomenon.

The agricultural modernization, namely the use of powerful machines, has favoured, unless requested, the destruction of wildlife habitats (hedges, isolated trees, pools, verges, ...). Landscapes have also been more or less deeply modified following the plots enlargement, the disappearance of hedgerow networks or isolated trees, the homogenization of the landscape colours, ...

The quantity of fossil energy required by agricultural labour and inputs processing (especially the N fertilizers) has quickly increased with the agricultural intensification.

In the Western European countries, agricultural surplus has led to the creation of dairy quotas (in 1984 in the European Union) or to the decrease of meat prices. The existence of these production surplusses has involved important costs for the public authorities. These costs are considered as excessive by certain lobbies.

In the Central and Eastern Europe countries which had a planned economic system before 1989, the situation is often very different. The farm holdings are small (AA < 10 ha) either because they remained private and selfsubsistence oriented (Poland) or because small farms have been reconstituted through the dismemberment of cooperative or State farms (Rumania). Big holdings, farmed in common as cooperatives, still exist in some countries (Slovakia, Czechia, Poland, ...). Very often, production has remained or has become extensive following inputs shortage, imported products competition, insufficient demand or bad markets organization. It can be foreseen that agriculture will be more intensive in the future in these countries.

Western Europe itself has a wide range of systems. The intensive forage systems are mainly split in the Atlantic climate plains from Northern Denmark to Brittany, in France, also going through the British Islands, the hilly regions of Southern Germany, Western Switzerland and the Pô valley in Italy.

The social, environmental and economic reasons for extensifying to a certain extent the forage production are thus justified at a general level (namely macro-economic).

At the farmer's level (micro-economic level), motivations to extensify are much less clear. In the European Union, the fall of meat prices has involved a large decrease of the suckler cows' husbandry profitability. In this system, benefit tends to equal the compensatory payment. In all the systems, intensive dairy systems included, the profitability maintenance is obtained by a decrease of the production costs and wastes.

In practice, a certain extensification has already been started. The European cattle stock (Europe with ex-USSR) has decreased by 10 million head in the 80's while the number of sheep was increasing by 24 million head (FAO, 1981 and 1991). In the European Union (EUR 12), the number of dairy cows has slightly diminished since the creation of milk quotas in 1984: 25.5 million in 1980 against 21.3 million in 1993. The cattle stock in its entirety has also decreased: 84.8 million in 1982 against 78.6 million in 1994 (CEC, 1990 and 1995).

This paper especially concerns the possibilities and the probable effects of grasslands extensification in the temperate region of Western Europe. Indeed, in the Mediterranean region, pasture is most of the time already extensive. In the previously planned economy countries, future concern will be mainly to intensify production while avoiding detrimental effects on the environment as it is observed in Western Europe.

DEFINITION AND OBJECTIVES OF EXTENSIFICATION.

The notions of intensification and extensification can be related to various production factors: land, labour, capital. In Western Europe, land is becoming the less limiting factor. The extensification then consists in using more soil while diminishing the inputs and consequently the stocking rate. This has many consequences on the whole production system. Even if the grasslands yield is reduced, the individual animal performances must remain high enough to obtain an acceptable income per animal.

The notion of extensification is very relative because it depends on the starting level. Indeed, the real observed yield can be equal or lower than the potential yield (no restriction in fertilizer and in genetic potential). If the potential yield is reached, any yield reduction can be considered as an extensification. If the real yield is much lower, the production system can be considered as extensive. However, it can still be more extensified. It is very difficult to determine a limit, a proportion of the potential yield, according to which a system can be considered as extensive ! The following scale can be proposed as an example:

80-100%	very intensive
60-80%	intensive
40-60%	extensive
0-40%	very extensive

These limits are of course arbitrary. On the other hand, it is possible to compare the yield of a particular plot with the potential yield of a region. Various authors have tried to define potential yield regions in Europe. Referring to Lee's research (1983), Hume and Corrall's (1986), Jones and Carter's (1992) as well as to an important data set collected by A. J. Corrall (Grassland Research Institute, Hurley, GB) within the framework of the project entitled "The prediction of production from grassland" of the FAO-Sub-network for Lowland Grassland, Peeters and Kopec (1996) have tried to determine these potential yield regions. Their results have been reworked and are summarized in fig. 1 and 2.

Other extensification indicators can be proposed.

According to Jullien (1991), extensive systems in France can be qualified as the inferior quarter of stocking rate distributions in each region. Relating to this criterion, the "extensive" stocking rates in this country are lower than 1.2 LU/ha of forage surface in dairy production systems, 0.8 LU/ha in cattle meat production systems and 0.6 LU/ha in sheep meat production systems.

The N fertilization per ha can also help to characterize the systems. In any case, it must be lower than 100 kg N/ha to be qualified as extensive. In the very extensive systems, it is nil. This criterion is however turned off if legumes fix significative quantities of N in the swards.

More sophisticated criteria can relate to the forages N, P and K nutrient indices (Thélier et al., 1992).

FACTORS INVOLVED WITH EXTENSIFICATION

The extensification of forage systems can be carried out in several ways. Several factors can be involved, it is obvious that the interactions are often strong between these factors especially between the land, the fertilizers and the concentrates.

Less concentrates and a better valorisation of roughage. The feeding systems can be extensified by reducing the quantities of concentrates distributed to the animals, namely to the dairy cows. This implies a better utilization of roughage in order to maintain animal productions. The grassland yields are not reduced, the fertilisation stays essentially unchanged. The quality of grass offered to the animals is, however, better controlled and the rate of substitution of roughage by concentrates is reduced. The quantities of milk from roughage can so vary between 0 to 5,500 l/cow (Schneeberger, 1987a and b). This constitutes an important financial saving for the farmer. A quick improvement of the forage efficiency has been observed in that way since the setting up of the milk quotas. Fig. 3 represents the increase of the amount of milk production per cow from the roughage of the farm and the reduction of stocking rate of the dairy cows in 10 years in Pays de Herve (Belgium). This stocking rate reduction results from the continual increase of cow performances, of about 100 l milk/cow.year. The number of cows required to reach the quota decreases thus with time. In this case, the N fertilization was not reduced.

Temporary or permanent grasslands? In Europe, the grasslands can be classified in two categories, the permanent grasslands that are often more than 20 years old and the temporary grasslands. The permanent grasslands occupy the major part of the area. They are often farmed extensively but certain intensive systems use them too. In this case, these grasslands are mainly grazed. The good grasses, among which are mainly the perennial ryegrass, are dominant in the sward; the quality of their sward is thus good. The temporary grasslands are intensively managed by cutting or grazing. The countries of the North of Europe and the British Isles use traditionaly more temporary grasslands for grazing than the countries located more southerly. The swards of these grasslands are often destroyed every 4 to 5 years and reseeded after ploughing or, more and more, without soil tillage. This technique allows very important productions 1 to 2 years after the year of sowing. After that, the sward deteriorates progressively. The technique presents the disadvantage that the yield is strongly reduced the year of sowing. Hopkins et al. (1990) have organized an important trials network in the United Kingdom to compare the performances of permanent grasslands with perennial ryegrass sowings. The trials included 5 levels of N fertilization from 0 to 900 kg/ha. In a 4-year period, year of sowing included, the spontaneous grass swards were on average, at each N dosis, as productive or even more productive than perennial ryegrass. Moreover, the differences in quality between the two types of swards were small. This demonstrates that regular resowing of perennial ryegrass is far from being justified in every case.

The spontaneous grasses seem thus to have an important production potential. Frame (1991) has compared the yield of these "secondary" grasses with perennial ryegrass in a 6 cuts/year regime. He was able to show that certain species such as *Festuca rubra* and *Holcus lanatus* were more productive than perennial ryegrass at low or moderate N dosis (about < 200 kg/ha). They have thus an interesting potential in the framework of extensive systems. These conclusions probably have to be extended to other species for slow cutting regimes (2 to 4 cuts/year): *Arrhenatherum elatius, Alopecurus pratensis, ...*

Certain qualitative aspects should however be improved by selection in these species; digestibility for red fescue and winter resistance for Yorkshire fog, for instance.

The important yields of spontaneous swards at high nitrogen levels must probably be interpreted as the positive effect of species mixture that have a complementary repartition of their production during the season. The genetic adaptation of these ecotypes of grasses to the ecological characteristics of their station probably also explains these high yields.

The oversowing of perennial ryegrass in existing swards remains an interesting technique for high productivity systems. It can be considered as an extensification of the technique that consists of destroying the totality of the sward before sowing.

The oversowing of white clover in the grazed grasslands and of red clover in the cut temporary grasslands is also a solution to reduce production costs (seeds purchase, soil tillage, sowing and nitrogen fertilization).

Use of legumes. Legumes can play an essential role in extensified systems in order to reduce nitrogen fertilization while maintaining the yields at an acceptable level.

The use of white clover in grazed swards is particularly attractive for several reasons. White clover can bring to the sward important amounts of nitrogen by symbiotic fixation. Vertès and Simon (1992) estimated that the equivalent of a fertilisation of 150 to 200 kg N/ha is provided in that way to the system if the clover content in the biomass is about 30-40 %. For Frame and Newbould (1986), white clover could even fix on average the equivalent of 300 kg/ha of N mineral fertilizer. The quality of white clover is longer lasting than grasses (Frame, 1986). Its management is thus more flexible (Vertès and Simon, 1992; Pochon, 1981). It is very palatable; its presence in the sward can increase intake.

However, white clover is not much used by the farmers for several reasons. The price of N fertilizer is low and the price ratio between fertilizer and milk encourages the use of a source of mineral nitrogen. The yields of the grass/clover mixtures are less predictable, particularly in the spring. The growth start of these swards is often too slow compared to grasses + N. Finally, the proportion of clover in a sward can sometimes collapse unpredictably; this leads to important yield losses. It can however provide interesting yields in milk and meat (see below).

Red clover can produce high yields in cutting mixture in the first year of production. Carlier et al. (1989), for instance, have recorded for these species intermediate yields between Italian and perennial ryegrass fertilized with 400 kg N/ha. However, this species is less persistent and often disappears as early as the second year. It is indeed sensitive to fungal diseases (*Sclerotinia* i.a.), to nematode infestation and it is badly injured by heavy machines. Moreover, the accumulated biomass is partly lost during wilting by leaf losses. The harvest of pre-wilted forage (30-35 % DM) for silage making can avoid to a large extent this disadvantage. In the future, the interest of annual oversowings of this clover in grass swards should be tested.

Lucerne is sensitive to soil quality. This has to be deep and of neutral or basic pH. In these conditions, it is very productive and persists for 3 to 4 years. Sibma and Spiertz (1986) have recorded for this species yields of 13.4 to 18.1 t DM/ha. These yields are typical for West Europe. Nitrogen fixation has been estimated by these authors at almost 500 kg N/ha. Unfortunately, leaf losses at wilting are also observed for lucerne. There is a renewal of interest in the cropping of lucerne in certain regions.

Optimum use of animal manure. Because of the low price of mineral nitrogen, farmers tended, in the past, to consider animal manure as a waste instead of a fertilizer. But the N, P and K contents of farmyard manure and slurry are far from negligible (table 1) though they vary in accordance with the animal type, the feeding type, the housing type, the proportion of straw in the farmyard manure or the addition of rinsing water in slurry. However, only a part of the amount of nutrients of the animal manures is available for the plants in the year after spreading (table 2). Indeed, a part of nitrogen is lost in the atmosphere during spreading as NH_3, a part can be leached as NO_3 during the winter, a part is denitrified as N_2 or N_2O, a part is immobilized in the soil as organic matter. The proportion of available nitrogen depends more particularly on the time of spreading, on the method of spreading (incorporation or on surface) and on the soil type.

The animal manures are heterogenous material. In order to homogenize the slurry, it is recommended to mix it before spreading. Regular analysis of farmyard manure and slurry can also help to better take into account their fertilization value.

The application of these manures on a grassland sward causes nevertheless problems of palatability if the grass is grazed within the month after spreading. It is thus recommended to spread them on grasslands assigned to cutting. A bad repartition of farmyard manure can also damage the sward.

In order to avoid these disadvantages, the farmyard manure can be composted. This processing is encouraged in certain regions for limiting nitrogen leaching from the manure heaps. Compost application over long periods increases the amount of nitrogen mineralized from the organic matter of the soil. The after effect of compost spreading during 10 years has been evaluated by Limbourg (1992) at 80 kg N/ha for 10 t and 120 kg N/ha for 20 t of compost.

Reduction of mineral fertilisation. The reduction of nitrogen fertilization is obviously in the center of the grassland extensification problem. It can be considered in different ways.

Case A. The animal production per ha is maintained, the mineral nitrogen fertilization is slightly reduced. This objective can be reached by:

- increasing the milk production per cow by selection and breeding (% Holstein blood namely). This allows reduction of the stocking rate. The grass production can then diminish and the use of N fertilizer can be reduced;

- on grass swards, it is usual to apply a standard dressing of nitrogen after each cut or each grazing. It will probably be possible in the future to adjust this dressing to the results of an analysis of the soil nitrate content. This strategical fertilisation should make possible a reduction of the N fertilizers while maintaining the production.

Case B. The animal production per ha is reduced, the mineral nitrogen fertilization is reduced or suppressed.

- Perennial ryegrass/white clover mixtures can sustain equivalent animal performances to those of perennial ryegrass + N swards providing that the available grazing area is increased. Bax and Schils (1993) have shown it in their experiments with dairy cows in Scotland and in the Netherlands. In Scotland, when the available area was 25% higher for the grass/clover mixture (1.9 LU/ha against 2.4 LU/ha) than for the grass + 350 kg N/ha, the productions per cow were identical (5,720 l/cow) for similar amounts of concentrates (1,100 kg/cow). In the Netherlands, the pure stands of perennial ryegrass received 275 kg N/ha and the perennial ryegrass/white clover mixture 75 kg N/ha. The area devoted to the grass/clover mixture was 20 % higher. The amounts of concentrates were similar in the two systems (almost 1,590 kg in 90/91 and 1,660 kg in 91/92). The dairy cow performances showed a slight advantage for the grass/clover system in 90/91 (7,400 l and 7,200 l/cow), in 91/92 the performances were identical (7,175 l/cow). Encouraging results were also noted in meat production (Steen and Laidlaw, 1985; Younie et al., 1987; Young, 1992; Moore et al., 1992).

  The management of these grass/clover swards can be associated with a low tactical nitrogen fertilization if the production is insufficient, particularly in the spring. This technique has however to be used with care. In order to fill up the grass deficit in the growth beginning, it is also possible to plan a certain area devoted to temporary grasslands with Italian ryegrass/red clover or lucerne, or even to grass + N to take silage cuts in the spring.

- When the nitrogen fertilization is reduced at a level of almost 100 kg/ha, certain species of spontaneous grasses and many permanent grassland swards are as productive as young swards of perennial ryegrass. If a bigger area can be used, then fertilizer and sowing economies are possible. In the future, it will be perhaps possible to look at long term mixtures of selected varieties of secondary grasses, associated or not with clovers.

- In these semi-extensive systems, the optimum use of organic fertilizers is essential for avoiding too strong production losses.

It is worth noting that the nitrogen fertilisation suppression, the use of legumes and the optimal valorization of organic matter are principles applied in organic farming.

Case C. The animal production per ha is reduced, the mineral nitrogen fertilization is totally suppressed. Although the experiment of Bax in Scotland for instance and the experience of effective organic farmers reveal that important productions are possible without nitrogen fertilizer, the management of such systems based on legumes is complex and probably unapplicable in difficult situations. In many cases, when the nitrogen fertilization is abolished, it concerns really extensive systems that can only be imagined in marginal regions (too wet, too dry or too poor soils, too steep slopes, unfavourable climates). The stocking rate often falls then below 1 to 1.2 LU/ha of forage area.

The reduction of P-K fertilization can also be considered. In intensive systems, the purchase of P-K fertilizers is often no longer necessary. The inputs of these nutrients in concentrates and purchased fodder are generally sufficient. In other respects, the outputs of these nutrients in animal products are low. In more extensive systems, regular soil analysis (every 3 to 5 years) remains the best guarantee of a good management of these nutrients. Economies are then often possible with respect to fertilization based on pre-established norms.

EFFECTS OF EXTENSIFICATION ON THE ENVIRONMENT AND ON THE FARMERS INCOME.

Certain positive effects of extensification are expected on landscape, biodiversity, quality of products, reduction of pollution and energy savings. These effects are however not automatic and must be discussed. It is also important to specify that extensive systems are not necessarily sustainable, though a priori they are more likely to be so than intensive systems.

A great benefit of extensification for society should be the maintenance of the territory occupation. Extensive systems can afford the use of fallow land or land under abandonment in socially desertified areas. They contribute in this way to the maintenance of landscapes. They can easily make optimum use of land complementary (highland pasture, marshland, ...) to their main production land. They are thus natural partners of tourism and in particular agri-tourism, especially in hill and upland areas. They can also create a complex structure in the landscape and colour differences between plots because extensive systems have to make the best use of the differences of habitats, while intensive systems tend to erase these differences. They adapt themselves to the characteristics of these areas. It is the case for instance with low productive swards that produce a long lasting quality forage. These swards can be used as buffers in case of grass deficit. It is of course the more extensive systems (Case C) that have the best positive impacts on landscape.

The effect of systems on biodiversity is also very variable according to the intensification level. As far as meadow birds are concerned, many large species profited by nitrogen fertilization. This phenomenon is very clear in the Netherlands where breeding populations of meadowbirds have strongly increased these last decades. These birds make profit of the soil life increase (worms, insects, ...) encouraged by N fertilizer. It is also the case of wild geese that winter in great number (almost 600 000 individuals in the Netherlands) by taking advantage of grass growth extended in autumn by the fertilizers. Grassland extensification should be detrimental to them but this is purely theoretical in the short term! Plant diversity on the contrary has badly suffered from grassland intensification. The food pyramids were strongly disturbed. The insect populations linked with certain plant species (particularly butterflies) have regressed. Certain bird species such as whinchat and corncrake are also under threat. Nitrogen increases indeed the proportion of productive grasses at the expense of other species (Mountford et al., 1993; Tallowin et al., 1994). That is how of the 50 to 60 species observed on 100 m^2 of mesotrophic grasslands, only 10 to 20 species are numbered in fertilized grasslands. Moreover, these last species are little interesting to insects and the rest of the food chain. The extensive management of grassland can only guarantee the existence of plant diversity in case of complete cessation of mineral fertilization and when the stocking rates are low or the frequency of cutting slow (2 cuts/year). This fits with case C. The application of these extensive techniques is however not sufficient. It is moreover necessary that the soils were not too enriched in nutrients in the past. The soil phosphorus content seems to play a key role in this field (Janssens et al., 1997). If diversity has to be restored from an impoverished community, it is also necessary that the soil seed bank includes interesting species and/or that the seed rain of these species is sufficient. The positive effect of extensification on plant community diversity is thus far to be observed in every case (McDonald et al., 1996; Thompson et al., 1997).

The decrease of nitrogen fertilization and stocking rates has on the contrary almost always beneficial effects on the losses in NO_3 by leaching and in NH_3 by volatilization. In grazing, the reduction of N fertilizer decreases the urine content of this element. This is very important since the losses occur mainly from the urine patches. The model of Scholefield et al. (1991) intends to predict these losses in the case of beef cattle grazing fertilized grasses without concentrates. Fig. 4 presents the prediction of this model in the case of a permanent grassland. Below a fertilisation of 100 kg N/ha, the losses are low. They are about 23 kg N-NH_3 and 18 kg N-NO_3. Above this fertilization, the losses are increasing rapidly.

The benefit of extensification in terms of phosphate pollution (eutrophication) of water can be important, especially in the case of well-drained soils with a shallow water-table and close to watercourses.

Extensification of forage production can be an opportunity to improve the quality of products. This quality can eventually be protected by a label as in organic farming. The extensive systems can also use hardy breeds, less productive but characterized by a meat with superior organo-leptic qualities in comparison to breeds used in intensive systems. The quality of milk products, and especially cheese, can also profit by a fertilizer reduction, a diverse flora, the renouncement of silage for hay making, ...

Although the research in this field is still little developed in Europe, it is highly probable that extensification improves the energy yield of agriculture. Indeed, the synthesis of nitrogen fertilizer from atmospheric nitrogen alone requires a great amount of energy. The substitution of N fertilizer by land or symbiotic fixation can only reduce the consumption of fossil fuel.

Extensification of grasslands risks, however, negative effects on the farmers' income. Extensification implies indeed that agricultural area is accessible, mobilisable and relatively cheap for making possible the increase of farm holdings. Moreover, in many regions, extensification will only be considered if there is a drop in land charges (social charges and structural costs) (Béranger, 1992). The public authorities should thus diminish the land taxes and the income taxes levied per ha if they want to encourage extensification. The farmer has also to pay attention not only to reducing his variable costs (fertilizers, concentrates,...) but also his fixed costs per ha (building, machinery, ...). A change in mentality will also be necessary because the performance of a cattle breeder would not be judged on the basis of his yields or of his use of inputs. It is the income per worker that must remain the criterion of success and performance of the farmers (Pfimlin, 1992).

EXTENSIFICATION AND THE CAP AGRI-ENVIRONMENTAL SCHEME.

It is worth mentioning here the CAP agri-environmental scheme because it has the double objective of extensifying production and of improving environment quality. Its application procedures vary according to the countries but it is always based on a voluntary involvement of farmers. The latter receive a premium for the concrete actions that they achieve in favour of the environment. This allowance is paid at 50% or 75% by the European Commission budget. It is limited to 300 ECU/ha. Among the most important measures adopted by the States as far as grasslands are concerned, are:

- grass premium: it is paid per grassland ha. It tends to limit the grasslands ploughing and their replacement by cereals and maize;

- low stocking rates (< 1.4 LU/ha). Objective: to limit fertilizers in the valley bottoms (pollution decrease), to maintain an open landscape (space occupation), to encourage fauna and flora;

- late and very late cuts associated to a total or a partial reduction of fertilizers and herbicides. Objective: to encourage the flora and the fauna;

- herbaceous field margin or strip of extensive grassland on arable land or grassland sides, namely on the water course border. Fertilizers and herbicides are prohibited. Objectives: to encourage the fauna and flora by creating corridors of species dispersion, to protect the surface water quality.

- replacement of maize forage crops by grasslands. Objective: to protect soil water from pollution by nitrate and atrazine.

- sowing of an associated plant (grass) in the understorey of a maize crop. Objective: to catch the nitrate after harvest, to make the use of atrazine impossible .

Moreover, certain states promote the implementation of a management programme for the whole farm, i.e. namely the PI programme in Switzerland. These programmes often include a reduction of the inputs use. These programmes tend to orientate the extensification towards sustainable systems.

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Table 1
N, P_2O_5 and K_2O contents of cattle farmyard manure and slurry in Switzerland (Ryser et al., 1994) and in France (Ziegler and Heduit, 1991)

		N	P_2O_5	K_2O
Switzerland	Cattle slurry (kg/m3)	4.5	1.7	9.0
France	Dairy cow slurry (kg/t)	5.0	2.5	6.0
	Beef cattle slurry (kg/t)	5.2	3.1	5.0
Switzerland	Cattle farmyard manure (kg/t)	4.5/5.5	3.2	7.5
France	Dairy cow farmyard manure (kg/t)			
	- free stall housing	5.5	3.5	8.0
	- stanchion stable system	7.7	3.1	4.4
	Beef cattle farmyard manure (kg/t)	3.9	3.7	4.0

Table 2
Values of % availability of N, P2O5 et K2O the year of spreading for slurry and farmyard manure in Switzerland (Ryser et al., 1994) and Walloon Region, Belgium (Toussaint and Dehareng, 1996)

		% of availability		
		N	P_2O_5	K_2O
Switzerland	Cattle slurry	55	100	100
Walloon Region	Cattle slurry	50	85	100
Switzerland	Cattle farmyard manure	30-35	100	100
Walloon Region	Cattle farmyard manure	10-20	100	100

Figure 1
Map of potential production (t DM/ha) in Europe (modified after Lee, 1983). Production classes overlap.

Figure 2
Map of potential production (t DM/ha) in Europe (modified after Lee, 1983). Production classes do not overlap.

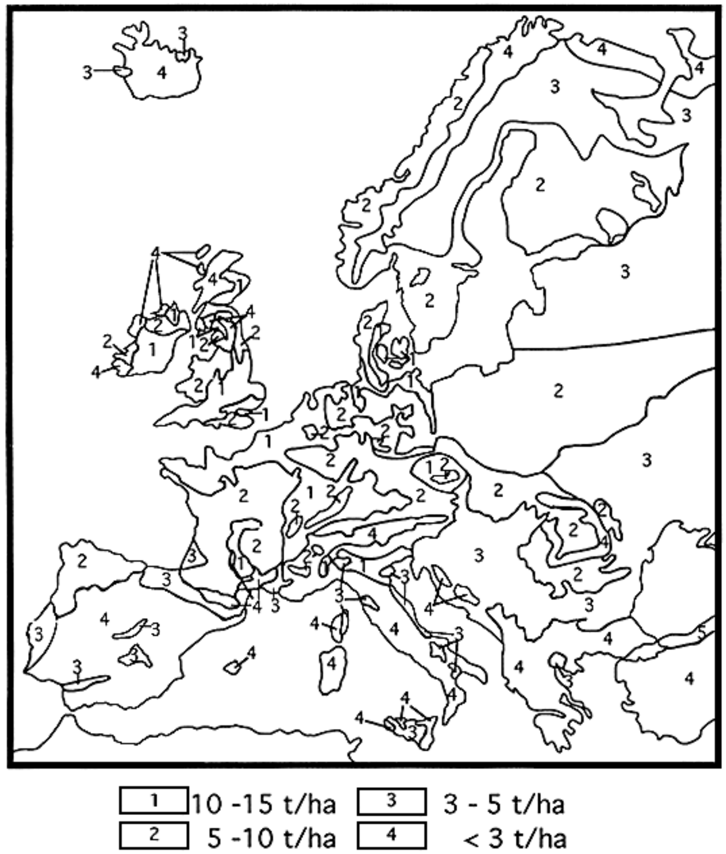

Figure 3
Evolution of stocking rate (dairy cows/ha) and milk from roughage (l/cow) since the setting up of milk quotas (1984) in the Pays de Herve, Belgium (Data source: APEDB-Herve).
Remark: Total milk production/cow was 4 800 l in 1984 and 6 400 l in 1994.

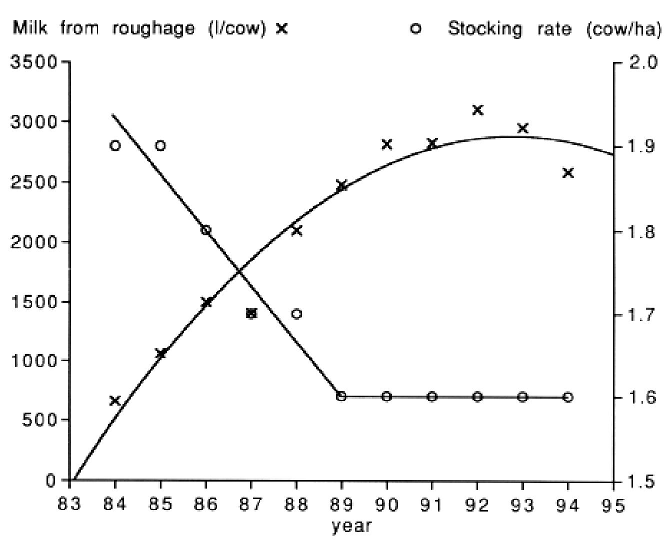

Figure 4
Evolution of N losses (volatilisation, denitrification, leaching) with N fertilization in permanent grasslands (after Scholefield et al., 1991). Considered case: Moderate drainage, loam, immission: 35 kg N/ha, permanent grasslands > 20 years old.