European Perspectives on Rural Development

European Perspectives on Rural Development is a series which offers new and refreshing insights into European rural development whilst emphasizing the specific and heterogeneous nature of the European countryside, it's regions and agricultural systems.

BORN FROM WITHIN *Practice and Perspectives of Endogenous Rural Development* considers rural development practices that rely on the use and re-valorization of local resources. Important here are local knowledge and skills, the ecosystem in the area, specific products and organizational solutions, and the interface between local actors and distant policy makers, consumers and agronomists. Perspectives on endogenous development arise through the comparative analysis of heterogeneity and associated styles of farming in Europe.

The series is published under the auspices of the Circle of European Studies (CERES) and Wageningen Agricultural University.

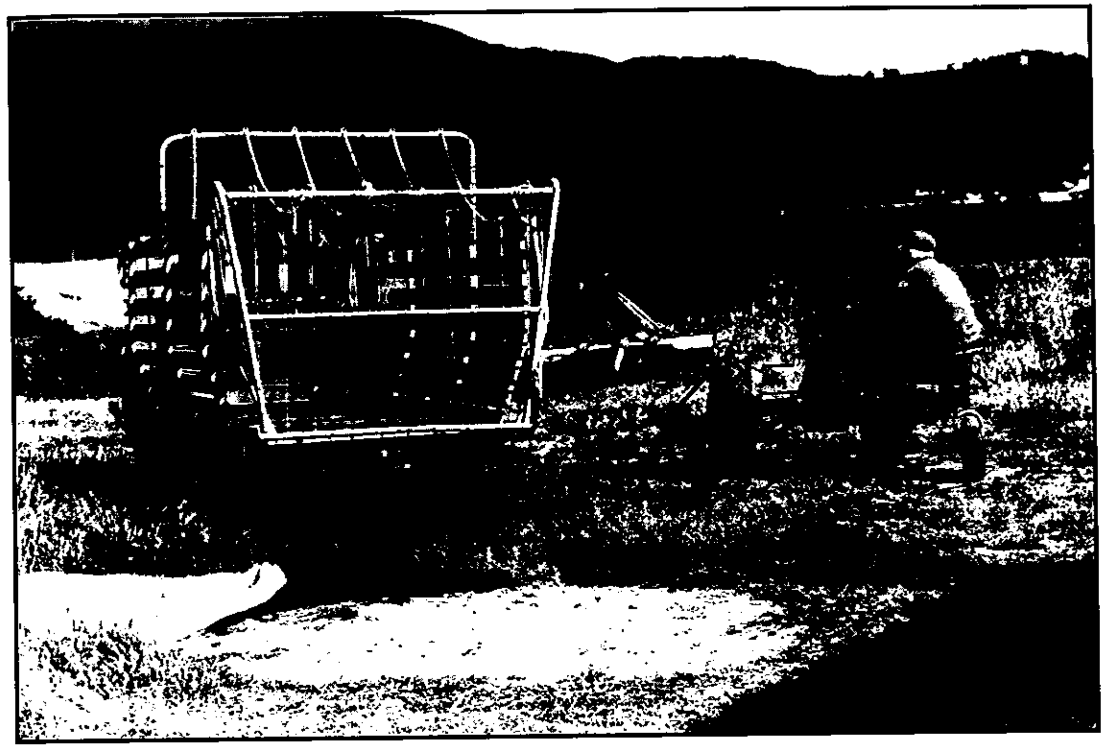
ISBN 90-232-2893-6

9 789023 228936

Van Gorcum, Assen, The Netherlands

Van der Ploeg • Long (eds) BORN FROM WITHIN

Jan Douwe van der Ploeg • Ann Long (eds)



BORN FROM WITHIN

•

Practice and Perspectives of Endogenous Rural Development

BORN FROM WITHIN

[illegible]

April 94

European Perspectives on Rural Development

European Perspectives on Rural Development is a series launched by the Circle for Rural European Studies (CERES). The heterogeneity and specificity of Europe's rural settings and the consequent need for well-elaborated rural development strategies provide the general framework for the series. Within this framework, local initiatives, the challenge of diversity, the need for sustainable development, the problems and perspectives of marginal areas and new responses to the current crisis in agriculture are some of the highly significant issues that will be dealt with in the forthcoming volumes. The series aims to contribute to theoretical debates on rural development within Europe as well as to the solution of a wide range of practical issues that are now central to many rural regions.

Several of the leading Agricultural Universities, Faculties and Research Institutes of Europe are participating in the CERES network. Amongst these are Wageningen Agricultural University in the Netherlands; the University of Trás-os-Montes and Alto Douro in Vila Real, Portugal; the Escuela Tecnica de Ingenieros Agronomos of the University of Cordoba, Spain; the Universities of Newcastle-upon-Tyne and of Hull, Great Britain; the University of Galway, the Republic of Ireland; the Mediterranean Agronomic Institute in Chania, Crete, Greece; the CESAR Institute linked to the University of Perugia, Italy; and the University of Gödöllö, Hungary.

Jan Douwe van der Ploeg • Ann Long (Eds)

BORN FROM WITHIN

Practice and Perspectives of Endogenous Rural Development

1994
Van Gorcum, Assen, The Netherlands

CIP-DATA KONINKLIJKE BIBLIOTHEEK, The Hague, The Netherlands

Born

Born from within: practice and perspectives of endogenous rural development / Jan Douwe van der Ploeg, Ann Long (eds); [photogr.: Hans Dijkstra]. – Assen: Van Gorcum. – Ill. – (European perspectives on rural development)
With ref.
NUGI 835/651
Subject headings: rural sociology / agricultural economics.

ISBN 90-232-2893-6

Photography: Hans Dijkstra/Audio Visueel Adviesburo De Dijk, Wageningen
Dtp: A. van der Lande, Wageningen
Lay-out & print, Van Gorcum, Assen

Table of Contents

Preface — VII
Gianfranco Rossetto

PART I: THE PRACTICE OF ENDOGENOUS DEVELOPMENT

1 Endogenous Development: Practices and Perspectives — 1
Ann Long and Jan Douwe van der Ploeg

2 Styles of Farming: an Introductory Note on Concepts and Methodology — 7
Jan Douwe van der Ploeg

3 Farm Household Strategies and Styles of Farming: Assessing the Utility of Farm Typologies — 31
Sarah Whatmore

4 Practices of Endogenous Development in Barroso, Northern Portugal — 38
Artur Cristóvão, Henk Oostindie and Fernando Pereira

5 Manuring in Barroso: a Crucial Farming Practice — 59
Ester Portela

6 Revitalization of Farmer Managed Irrigation Systems in Trás-os-Montes — 71
Adri van den Dries and José Portela

7 Ecological Wine-making in a Depressed Mountainous Region in Southern Spain — 101
Gaston Remmers

8 Transformation and Consumption of High-Quality Meat: the Case of Chianina Meat in Umbria, Italy — 128
Flaminia Ventura and Hielke van der Meulen

PART II: ENDOGENOUS DEVELOPMENT: PERSPECTIVES AND PROSPECTS

9 On the Relationship Between Central Regulation and the Potential for Local Initiatives: Some Reflections on the Growing Scope for More and Better Research 163
Bruno Benvenuti

10 Theoretical Aspects of the Study of Endogenous Development 184
Bill Slee

11 The Relations Between Central and Local Powers as Context for Endogenous Development 195
Antonio Picchi

12 The Rural Development Challenge in OECD Member Countries 204
Christian Huillet

13 Regional Marginalization, Styles of Farming and Technology Development 217
Dirk Roep and René de Bruin

14 Linking Technological Research to Different Problem Definitions, Perspectives and Interests in the Countryside 228
Cees de Roest and Silvio Antonello

15 Farming Systems Research for Sustainable Agriculture 245
David Gibbon

16 Quantitative Techniques for Rural Development, With Particular Reference to Input-Output Analysis 255
Kenneth Thomson

17 Sustainable Agriculture and Endogenous Development: a Socio-Political Perspective 262
Jonathan Murdoch, Neil Ward and Philip Lowe

References 280

List of Contributors 297

Notes

1 We wish to thank J.D. van der Ploeg for his contribution to the analysis of the field data.

2 The different styles of farming represent the following dimensions on orientation to milk production (OM) and cattle density (CD); intensive dairy farmers (OM>0.40 and CD>1.1); SCOM farmers (OM<0.40 and CD<1.10); Intensive meat producers (OM<0.40 and CD>1.10); extensive meat producers (OM<0.40 and CD<1.1).

3 For a detailed description of the importance of irrigation in Trás-os-Montes and the diversity in traditional farmer-managed irrigation schemes, see the chapter by J. Portela and A. van den Dries.

4 Older farmers are seldom selected for EC-grants, and although remittances from migration play an important role, the transformation of existing farms into the large scale, intensive and highly mechanized dairy farms go far beyond the reach of these remittances. Hence, external fundings such as EC grants, are crucial.

5 Dairy production was also of importance in some villages in Barroso at the beginning of this century, when farmers transformed milk at farm level into butter and commercialized this through local markets (Freund 1970).

6 The characterization of haylands and pasture lands based on soil quality and water availability is in practice not always that clear. Other factors such as the inclination of the fields and accessibility for machinery play a role as well.

7 At this moment it is only possible to compare the increase of livestock in villages which form an administrative parish, the minimal unit of aggregated agricultural data collection.

8 For a detailed description of the importance of organic manuring in Barroso's ecological conditions, see also the chapter of E. Portela in this book.

9 The quantities of chemical fertilizers refer to the total amount of fertilizers. In potato and maize cultivation it refers mostly to *Composto* (7:14:14). In the pasture lands *Nitrato* (20.5 percent N) is the most common fertilizer.

5 Manuring in Barroso: a Crucial Farming Practice

Ester Portela

In Barroso, sustainable agriculture is based upon diversity of crop and animal husbandry, nutrient cycling and utilization of all available endogenous resources. One of these resources is manure. Soil fertility has been improved by application of large quantities of farmyard manure and sheep, goat, and pig manure. Barroso farming has not been dependent on large inputs of fertilizers. However, those farmers who possess the conditions for higher crop intensification are increasingly applying larger amounts of fertilizers, frequently in inadequate quantities or inefficient proportions of nutrients. A more efficient fertilizer-use (energy consuming) could be reached if more was known about the fertilizer value of the several types of local manures and the methods and practices related to manuring. As J. Portela (1991) has emphasized, research is needed for a thorough characterization of the evolution and current conditions of Trás-os-Montes farming systems. Manure, a crucial endogenous resource, has been neglected by researchers, advisors of state laboratories and extensionists alike. Yet, it deserves much attention. Manures have a lot to do with the farmers' conditions of work, with energy saving and with ecologically sound agriculture. Obviously these aspects are closely related to the future of farmers and farming, both in southern and northern Europe.

The study of Barroso manures and manuring practices is part of the Vila Real research into endogenous development patterns. The specific research on manure consists of two components. One, a general study of the diversity of agricultural practices, assesses the relevance of animal manuring versus chemical fertilization in the different farming systems and was carried out in ten villages of Alto Barroso. The preliminary results are presented in Chapter 3 of this volume. The other, our own study, is a more in-depth approach to an understanding of manuring practices: how manures are 'manufactured'; how much is applied; which materials are used; which crops benefit the most; how endogenous; how labour intensive and onerous; what are the main constraints; and what is the fertilizer value of manures. The study is focused in only one village, Paredes do Rio (Alto Barroso) and is of an exploratory nature and as the research is not yet complete, the results presented here are preliminary in nature.

5 Manuring in Barroso: a Crucial Farming Practice

Ester Portela

In Barroso, sustainable agriculture is based upon diversity of crop and animal husbandry, nutrient cycling and utilization of all available endogenous resources. One of these resources is manure. Soil fertility has been improved by application of large quantities of farmyard manure and sheep, goat, and pig manure. Barroso farming has not been dependent on large inputs of fertilizers. However, those farmers who possess the conditions for higher crop intensification are increasingly applying larger amounts of fertilizers, frequently in inadequate quantities or inefficient proportions of nutrients. A more efficient fertilizer-use (energy consuming) could be reached if more was known about the fertilizer value of the several types of local manures and the methods and practices related to manuring. As J. Portela (1991) has emphasized, research is needed for a thorough characterization of the evolution and current conditions of Trás-os-Montes farming systems. Manure, a crucial endogenous resource, has been neglected by researchers, advisors of state laboratories and extensionists alike. Yet, it deserves much attention. Manures have a lot to do with the farmers' conditions of work, with energy saving and with ecologically sound agriculture. Obviously these aspects are closely related to the future of farmers and farming, both in southern and northern Europe.

The study of Barroso manures and manuring practices is part of the Vila Real research into endogenous development patterns. The specific research on manure consists of two components. One, a general study of the diversity of agricultural practices, assesses the relevance of animal manuring versus chemical fertilization in the different farming systems and was carried out in ten villages of Alto Barroso. The preliminary results are presented in Chapter 3 of this volume. The other, our own study, is a more in-depth approach to an understanding of manuring practices: how manures are 'manufactured'; how much is applied; which materials are used; which crops benefit the most; how endogenous; how labour intensive and onerous; what are the main constraints; and what is the fertilizer value of manures. The study is focused in only one village, Paredes do Rio (Alto Barroso) and is of an exploratory nature and as the research is not yet complete, the results presented here are preliminary in nature.

The persistent application of significant amounts of manure to soils with an already high content of organic matter, like those of Barroso, is intriguing. The paper reviews available data on manuring and fertilization and presents some hypotheses to explain that puzzling farming practice. Finally, the main constraints for the maintenance of manuring practices are discussed. The results and ideas presented here are based on several visits to the village of Paredes do Rio, on a review of the literature, and the results presented by Cristóvão, Oostindie and Pereira in Chapter 3.

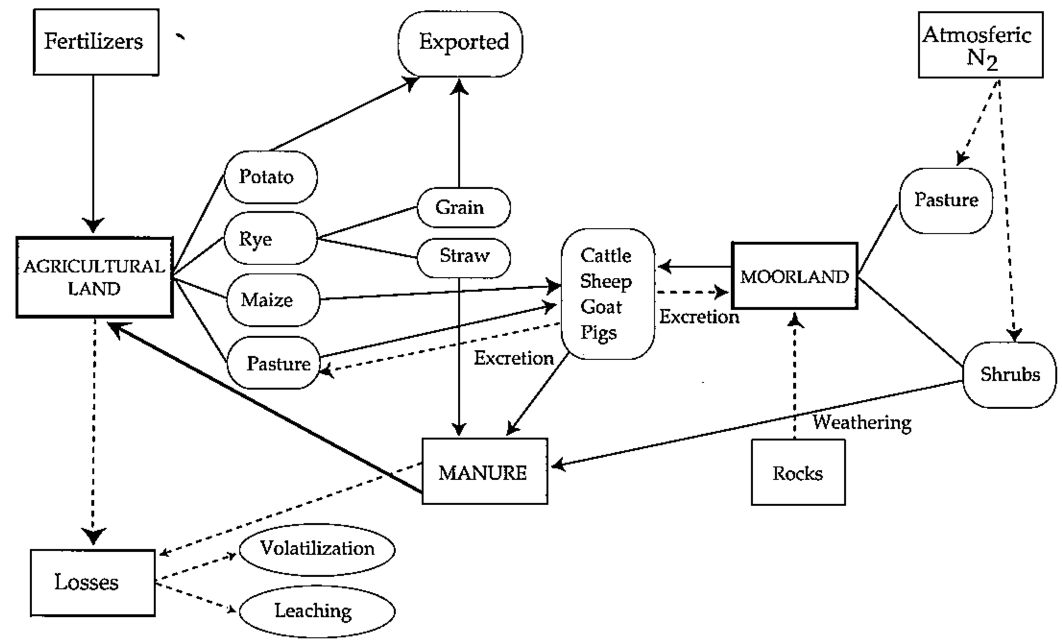
The Climate, Topography and Soils of Barroso are Unfavourable to Agriculture

Barroso is located in the western part of Terra Fria (Cold Land) in the Trás-os Montes region, in a range of altitudes between 700 m and 1300 m. Most arable land is located on hillsides with slopes < 15 percent and pasture land which is ascribed to steeper areas where slopes may reach > 25 percent. Mean annual rainfall varies from 1200 mm and may reach values higher than 1400 mm, with mean annual temperature from 12° C to values below 8° C. In spite of the ecological homogeneity, Barroso encompasses three climatic sub-zones: Terra Fria de Planalto, Terra Fria de Montanha and a Terra Fria de Alta Montanha.[1] The study was particularly focused on these two last subzones, which broadly coincide with the so-called Alto Barroso.

The high precipitation and low temperatures, particularly in autumn and winter, explain the high content of organic matter in the soils. The average value of organic matter in arable land is about six percent[2] and may often reach ten percent (Agroconsultores-Coba 1991). The most significant soil units are Umbric Leptosols, Umbric Cambisols and Umbric Regosols derived both from granites and schists. They might be described as coarse-textured, with high acidity, a low content of exchangeable bases and a high content of exchangeable aluminum.

Very cold temperatures during most of the year and erratic rainfall with dry spells are the main climatic constraints. The high rainfall is concentrated in autumn and winter, which can create poor aeration conditions, particularly in the depressions, and water stress in summer. Steep slopes restrict the area for arable crops because of the susceptibility of the soils to erosion and the lack of conditions for mechanization. The coarse texture of the soils and high acidity are the main soil-limiting factors. The former soil characteristic is responsible for the low water-holding capacity and the low reserve of nutrients. Acidity decreases availability of some nutrients and solubilises the aluminum, which reduces root growth. Both climatic and soil conditions restrict microbial activity, so the degradation of organic matter is slow-paced.

Figure 1 Relationships Among the Components of Barroso Farming System and Main Physical Flows



The Local Farming Styles Cope with Physical Constraints

The physical environment of Barroso imposes certain limits to agricultural production. However, farmer responses to such physical constraints are rather unique. The local styles of farming are diverse, complex and dynamic. J. Portela (1991) has described in detail the main components of farming activity in Terra Fria as well as their interrelationships. Most of them are common to those of Barroso. Figure 1 depicts in diagrammatic form the relationships between the components of the farming process: arable land, pasture land, moorland, livestock, manuring and also the main physical flows in the system.

Agricultural production is diverse and the intensity of land use is variable. The main produce is livestock and fodder to feed the animals. Cattle provide draught power and manure. Pig-raising, goat and sheep herding also provide manure for agricultural land. Pasture land (*lameiros*) provides fodder; arable land the potatoes, rye, maize and fodder; and household gardens provide vegetables. Rye, rye-fodder and potatoes (or maize) are cropped in a two-year rotation. More recently a four-year rotation was introduced in Barroso, which included two years of temporary improved pastures. The other extensive component of crop production is the moorland or commons (*baldios*), vast uncultivated lands where Leptosols, shallow and stony soils with some rock outcrops, predominate. The *baldio* is mainly perceived as grazing land, but it also supplies the shrubs (*mato* or *roço*) for bedding the animals.

Farmers try to use all available resources. Farmyard manure (FYM, *esterco*),[3] pig, goat and sheep manure are the principle sources for supplying nutrients and organic matter to agricultural land, which are mainly provided by the moorland which produces the fodder and the shrubs for bedding the animals. In addition rye and maize straw are entirely used for bedding. The greater part of the natural vegetation of the moorland area consists of Leguminosae, such as brooms, winged brooms and gorses, which have high nitrogen content, and constitute a significant source of nutrients and organic matter for the arable land. Irrigation water is used to increase grass growth and contributes to a better composition of grass species in the pasture (Prins 1991). Irrigation water is also used as a vehicle for transporting considerable amounts of nutrients and organic residues. Heavy rainfall drainage, in the spring, is diverted from the stables, pathways and yards along with cattle excretion to the fields (*água de surro*).

Nutrient recycling has been an important element of sustainable agriculture in Barroso. Such recycling not only reduced the need for additional fertilizer elements but simultaneously provided organic matter. Utilization of maize stalks, rye straw and shrubs from moorland for livestock bedding has been crucial for maintaining soil fertility. Animal bedding keeps the cattle clean and dry when they lie down in the stall and helps to soak up the urine and faeces, preventing nutrient loss from ammonia volatilization or leaching of nutrients. In this manner there is an improvement of the soil fertility of agricultural land, which results in the transference of organic matter and nutrients from the *baldio*. Mineral weathering constitutes a permanent supply of nutrients from the moorland. Soil acidity and high rainfall are favourable to this natural process. Depending on weather conditions, the cattle, sheep and goats are driven to the *baldio*, the commons, for grazing. During grazing, animals leave considerable droppings on the permanent pastures and natural vegetation of the *baldio* which, although uneven in its distribution, contributes to a degree of recycling of nutrients.

Application of wood ash from fire stoves to household gardens is another way of recycling wastes. Pig-raising is a manner of using waste from household and livestock food, and in turn the pig manure is applied to household gardens and maize fields.

Soil Fertility and Crop Productivity Have Been Maintained Through Manuring

Barroso farmers have perceived FYM and other animal manures as the main source for supplying nutrients to arable or pasture land. Animal manures were so important that sheep and goat herds were kept mainly for their manure (Gusmão 1964; Pires 1970). Prins (1991) also mentioned the relevance ascribed by farmers to the quality of sheep and goat manures. The reduction of goat- and sheep-raising, and the decrease in price of fertilizers has led to an increase in fertilizer application. However, farmers still apply significant amounts of FYM. In Barroso, livestock production is the main activity and the animals are kept in the stables long enough to provide significant amounts of manure. Prins (1991) indicates 10 m^3 of FYM per year per cow. As to Paredes do Rio preliminary results of this research indicate a mean value of 9.6 m^3 of FYM per year per cow.

The crops more abundantly manured are potatoes and maize and less frequently rye and pastures. According to Pires (1970) the average quantities applied are 25-30 t/ha^{-1} of FYM to potato and maize fields, and 12-18 t/ha to rye when not preceded by potatoes. More recent data collected by Cristóvão *et al.* (see Chapter 3) in 68 households of Barroso, confirm these rates of FYM application, and there is almost no difference between the four farming styles identified, 24-29 kg/ha^{-1} applied to potatoes and 23-28 kg/ha^{-1} to maize. Although pasture land is sparingly manured, those who apply it prefer well-matured and finely-divided manure (Pires 1970; Prins 1991). The data of Cristóvão *et al.* reveal that dairy farmers apply reasonable amounts of FYM for creating new temporary meadows. The authors also show that SCOM[4] dairy farmers apply more FYM in pastures and haylands than is observed in other styles. This might be due to the fact that they have substituted some of the arable land for pastures and hayland and have some FYM available that has not been used for enriching potato fields.

In the last decades the intensification of milk-oriented systems has led some farmers to build modern cowsheds, where the animals do not lie on shrubs and straw, and the slurry (faeces plus urine and wash water, *chorume*) is collected in large underground cesspools. In these systems the amount of FYM produced has been reduced and the more intensive dairy farmers no longer collect *mato*, but use rye and maize straw only in the traditional stalls that have been maintained to supply FYM for arable crops (Lima Santos 1992). The value of slurry as an organic amendment is negligible.

Intensive dairy farmers who have partially substituted FYM for slurry recognize that this type of animal manure (with its low content of organic residues) has a diminished effect on crop productivity. That is why most of them maintain some traditional stalls to produce FYM for arable land, reserving the slurry for pastures and haylands (Cristóvão *et al.*, Chapter 4).

Barroso Farmers Apply Low Amounts of Fertilizers

The actual amount of fertilizers applied by most farmers remains low. In general, it appears that fertilizers have failed to bring higher productivity, at least in low revenue crops like rye, maize and pastures. Fertilization of potatoes, the most marketable crop, is widespread now, although often in quite inadequate quantities or inefficient nutrient combinations. The relatively large quantities of FYM available, together with tight profit margins may explain the low consumption of fertilizers. The low profit margins may be related to a lack of information due to inadequate advisory services about what type of fertilizer, how much and when to apply. Very few farmers have analyzed the soils and fertilizer recommendations that are usually made by the cooperative salesperson. Lima Santos (1992) referring to the data of Gomes (1945) mentioned that the mean consumption of fertilizers[5] in Barroso in the 1930s was 11 kg/ha P_2O_5, the use of N fertilizers being zero. As to Montalegre county, Pires (1970) estimated that the mean consumption of nutrients in agricultural land for the year 196465 was 15 kg/ha N, 35 kg/ha P_2O_5 and 11 kg/ha K_2O. From the data collected by Bernardo (1988), in 18 households in the village of Morgade, it is possible to estimate the mean consumption of nutrients for the year 1986: 37 kg/ha N, 44 kg/ha P_2O_5 and 28 kg/ha K_2O. It is worth noting that farmers applied more phosphorous than nitrogen. In fact the input of N from biological N fixation on the moorland indicates that, in this system, phosphorus limits yield more strongly than nitrogen.

Data from 1982 to 1985 suggest that most farmers do not apply fertilizers to rye (Portela *et al.* 1986): only one fourth of the farmers interviewed applied nitrogen as top dressing at a rate of approximately 25 kg/ha N in 1982-83 and 1983-84 and two thirds applied a mean value of 40 kg/ha N in 1984-85. It must be pointed out that in this last year the rainfall during the winter was 400 mm above the mean value, whereas the two preceding years were average years. Farmers are unanimous in saying that application of ammonium nitrate depends on the year and whether the rye has a look of nitrogen starvation. They are very parsimonious in applying N, because most fields are preceded by potatoes, this crop being abundantly manured and fertilized. If additional fertilizer is applied the cereal might lodge. The same tendency was observed by Pires in 1970 and recently by Cristóvão *et al.*.

During the 1960s, there was no use of fertilizers in pastures or haylands. However, with the intensification of meat and milk production it became a more common practice. Bernardo (1988) mentioned the use of ammonium nitrate in permanent pastures in the village of Morgade. Lima Santos (1992) also referred to the intensification of milk production which was done by increasing fodder by introducing fertilizers in permanent pastures. Data by Cristóvão *et al.* show the utilization of higher rates of N fertilizers by milk producers. However, beef producers apply it at rather low rates and frequency.

In the past, maize fields only received FYM, the application of fertilizers being almost nil (Pires 1970; Bernardo 1988). Nowadays, farmers in the milk-oriented systems, use both the FYM and some fertilizers, the 7.14.14. Based on data of Cristóvão *et al.* it is possible to calculate an approximate value of 30 kg/ha and 60 kg/ha for P_2O_5 and K_2O respectively. However, fewer meat producers use it, and in low quantities too, and with less frequency.

Potatoes were the most marketable crop and it is the one to which the great majority of farmers abundantly, and many times excessively, applied fertilizers. Pires (1970) mentioned as an average fertilization of potatoes, 60 kg/ha N, 143 kg/ha P_2O_5 and 46 kg/ha K_2O for a mean production of tubers of 12.8t in Alto Barroso, and Bernardo (1988) mentioned average values of 60 kg/ha N, 80-100 kg/ha P_2O_5 and 70-100 kg/ha K_2O for 1986. Calculations based on the recent data of Cristovão *et al.* are not far from these latter in the milking systems, 60 kg/ha N, 120 kg/ha P_2O_5 and K_2O and somewhat lower in the beef systems, 50 kg/ha N, 100 kg/ha P_2O_5 and K_2O. Application of fertilizers depends, obviously, on the price of crop/cost of fertilizer ratio. Some farmers related that the amount of fertilizer applied to potatoes reached, in some years, 1 kg of fertilizer (7.14.14) for 1 kg of potato-seed. That means an average application of 120 kg/ha N, 240 kg/ha P_2O_5 and 240 kg/ha K_2O, which is very excessive, even taking high potato yields of 15-17 t/ha into consideration. This rate of application was observed some years ago, when potato prices were high and there were no market constraints on the demand side. These fertilizer rates were reduced to half when the price of crop/cost of fertilizer ratio was unfavourable.

In spite of the partial substitution of manure by fertilizers, the actual amount of N provided to crops is relatively lower than that supplied by manuring. According to the rough estimates of Lima Santos (1992) from three case-studies in 1989-90 of agricultural land, the contribution of N fertilizer depends upon the production system. 16 percent of the nitrogen applied came from N fertilizer in the beef-system and about 47 percent in the milk system. The results of Cristóvão *et al.* show clearly that, with the exception of potatoes, the inputs of fertilizers by meat producers are rather limited, both in quantity and in frequency. The irregular application of fertilizers to crops other than potatoes is related to any surplus left over from the potatoes, or to weather conditions.

Manures are Appreciated for Effects That Cannot be Expected From Fertilizers

In spite of the decrease in the price of fertilizers, dressings on agricultural land remain low. It is recognized by farmers that these cannot substitute for FYM. Farmers stressed that if they do not apply FYM, but use fertilizer instead, the productivity of arable or vegetable crops is drastically reduced over a two or three year period. This means that the effect of FYM is not limited to providing nutrients to crops but that it also increases nutrient availability. The effect of organic matter in reducing the intensity of phosphate fixation by soil Fe or Al hydroxides has long been recognized. The presence of gibbsite in the soils of Barroso is well documented by Silva (1980, 1983). Complexation of Al and Fe reduces the fixation of phosphate to hydroxides.

The dual role of organic matter as a microbial substract and as a determinant of the physical/chemical conditions in the soil environment is undeniable. In general, the organic matter has a significant effect on physical soil properties such as the increase of water-holding capacity or stability of soil structure. These soil properties are often mentioned by farmers as important aspects ascribed to the application of FYM. However, it seems that the immediate effect of FYM in promoting growth is more related to chemical and microbiological reactions that occur after its application. In fact Prins (1991) also mentions that farmers emphasize the rapid effect of manure on crop growth.

Few available data on the organic matter of Barroso soils refer to the C/N ratio and content of humic substances. Data from Agroconsultores-Coba (1991) and Coutinho (1989) show that the C/N ratio tends to be high (12-25) in most soils, and the percentage of humic substances is only 50 percent of soil organic matter. These data suggest a reduced degree of humification of organic matter, which means that the process of degradation is slow, therefore the mineralization of organic matter is also slow-paced. The slow rate of decomposition of organic matter is obviously due to reduced microbial activity. Low temperatures, soil acidity and poor aeration are related to the slow rate of decomposition of organic matter. Climatic constraints are particularly relevant from October to April, when temperatures are low and precipitation is high.

Although Barroso soils have a high content of organic matter, the application of reasonable amounts of FYM is seen as the only means of getting profitable crop yields. Jansen (1984) has shown that N mineralization is the more closely related to the amount of young organic matter than to the total N content of soil. The addition of young organic residues is also important to stimulating microbial activity, which accelerates the decomposition rate of native soil organic matter. Organic matter, as a nutrient store, releases nutrients gradually, providing essential nutrients that cannot be retained by soil for long. This is particularly relevant for nitrogen in the coarse-textured soils of Barroso, where leaching of N may not be negligible. Moreover, organic matter buffers growing plants against sudden changes in their chemical environment. Aluminum toxicity is a major problem in many soils of Barroso, restricting root growth and root ramification. However, it might be ameliorated by manuring, since Al is complexed by humic substances, reducing its solubility, and so its phytotoxicity.

Not all the energy released during oxidation of organic residues is captured by decomposing microbes, a considerable amount is dissipated by heat (Reddy *et al.* 1986). We admit that a possible rise in the temperature, due to enhanced microbial activity, hastens germination and encourages early growth. In fact, in Barroso, the planting of potatoes is a simultaneous operation with incorporation of FYM into the soil. The farmers assertion about the immediate effect of FYM on crop growth might be related not only to the increase in nutrient availability but also to the rise in soil temperature. The possibility of crop growth being stimulated by the application of FYM due to an increase of soil temperature is supported by the farmers' opinions about the quality of goat and sheep manures. They are known as 'hot manures' (*estrumes quentes*) due to the fact that when incorporated into the soil they provoke a noticeable rise in temperature.

Fertilizers lack many of these effects on the soil environment and are actually a complement to animal manures and are utilized mostly to supply phosphate, and for stimulating growth in the spring, as is the case with the application of ammonium nitrate as top dressing on pastures, hayland or rye.

Is There an Alternative to Traditional Way of Producing Manures?

FYM includes shrubs collected from the commons or moorland, the greater part of which consists of Leguminosae, which are able to use the nitrogen from air. So, in the cattle systems the nutrients that are supplied to the cultivated area are actually provided by the moorland that produces the fodder and the litter-bed. In this manner there is an improvement of the soil fertility of arable land, which results from the transference of organic matter and nutrients from the *baldio* to the arable land.

The research by Cristóvão *et al.* shows that farming systems oriented to milk production hardly use *baldio* for pasture. Lima Santos (1992) has also observed that the contribution of *mato* reduce has been reduced in milking systems, being almost nil in the most intensive ones. In these, some of the traditional stalls have been substituted by modern cowsheds where cattle slurry is collected in large underground tanks and animals are not supposed to lie on litter-beds. This results in a big loss of nutrients and organic matter as compared to the traditional method. An important input of N into the system is misspent: the N coming from the moorland, ascribed to nitrogen fixation in Leguminous shrubs. Besides, there are losses of ammonia inside the stables and losses also after spreading manure on the land. The utilization of cattle slurry represents a very high cost practice because it encompasses a tremendous waste of N and it could become an environmental threat. The loss of ammonia when animals are bedded is very much reduced because the shrubs and straw have a great capacity to soak up the urine and fix the ammonia (Kirchman 1985).

Today, a lot of concern exists about ammonia emission and data is available on the issue. According to Oosthoek *et al.* (1991) the emission of ammonia by cattle slurry during the housing period is approximately 1 kg of NH_3 per month per cow. Losses of ammonia during and after land spreading of slurry on arable land can vary from 20 to 80 percent of the NH_4-N and occur mainly in the first hours after spreading (Neeteson and Wadman 1990; Amberger 1991; Döhdler 1991; Vlassak *et al.* 1991). According to the measurements of Klarenbeek and Bruins (1991) the loss of ammonia (NH_3-N) due to the spreading of cattle slurry was 1.1 kg per m^3 of slurry applied.

Construction of modern stables with slurry tanks seems to be more attractive to farmers because it reduces labour for collecting *mato* and for most of the operations described above. Moreover, spreading of slurry is a mechanized operation, using a vacuum tanker with a spreader. However, building modern cowsheds has been associated only with milking systems and, in fact, these systems have low expression in Barroso as yet. The last official estimate indicates that milking cows represent less than 12 percent of all cattle (RGA 1989). According to Lima Santos (1992) the low number of milk producers is related to topographic limitations that restrict mechanization and the availability of land for producing hay. The limits to mechanization was favourable to the maintenance of animal traction and to the better use of a more available resource, the *baldio*. It has also been observed that some farmers dislike the new system of housing the animals for reasons of climate and hygiene. Bedding the animals offers better protection against the cold. In fact, some farmers are using straw for litter-beds in these stables for the comfort of the animals as well as for getting more FYM.

In conclusion, we would say that the substitution of FYM by slurry is perhaps not a good alternative, due to the physical constraints, the wasting of nutrients and the jeopardizing of the environment.

Can Farmers Maintain the Production of Farmyard Manures?

The traditional way of producing FYM seems to be correct from a technological and ecological point of view, and should consequently be maintained. But, can farmers maintain its production?

The answer, ultimately, will be linked to the following considerations: a) to the crops that benefit the most; b) to landscape conditions; c) to the farmers working conditions; d) to the labour needed. While the three last factors constitute the driving forces in the decline of manuring, the increase or maintenance of both maize and potatoes hectarage will likely sustain the practice. This situation occurs in relation to a possible expansion of both seed-potato hectarage and the local cattle breed. But the factors pushing the decline of manuring are powerful. Indeed, the production and application of FYM to the fields is highly time-consuming and requires a lot of unpleasant, hard manual work, which is increasingly intolerable for old farmers. The effort to obtain *mato* seven to nine times per year and spread it in the stalls is a laborious job and involves many operations. For example, it consists of going to the *baldio*, cutting, collecting, loading, tying with rope, transporting, unloading and spreading in the stalls. This process is repeated several times a year for new layers of *mato*, and almost daily with straw, which takes time, and requires hard physical effort. Moreover the accessible areas of the moorland are also those which have been over-exploited. So, farmers have to drive further and further afield for shrubs. The most attractive areas for obtaining *mato* are the more levelled-off areas with no stones or rocky outcrops. There, the work can be done quickly without risk of damaging the blade of the mechanical mower.

The chore to load wagons or ox-carts with FYM, to drive them over bad paths, between narrow walls, and up and down steep slopes is also hard, unpleasant and time-consuming work. The stalls have small entrances which therefore cannot admit wagons. So, FYM has to be manually shifted out of the stalls with a fork and loaded onto wagons, and since all fields are fenced in by walls and many paths are narrow, they do not always allow for the transit of the wagon by tractor, which means that farmers have to push an ox-cart with the FYM.

Although many farmers use a mechanical mower to cut *mato*, some still use a hoe or a scythe. For the village of Corva, Prins (1991) relates how 'middle farmers' still make use of traditional methods, using no equipment for spreading FYM. The manure is dropped off in small heaps and later on is spread all over the field and ploughed under with a tractor.

Conclusions

It seems that building modern cowsheds for producing slurry is not an appropriate solution in Barroso for reducing labour or the hardship of work. Few alternatives are left, beyond improving the tracks to the *baldio* and the paths to the fields, widening the paths by moving the walls, building new stalls with larger entries and a search for adequate equipment for the special landscape of Barroso.