ECOLOGICAL BASIS FOR LOW INPUT AGRICULTURE[1]

Juan Gastó[2]
José E. Guerrero
Francisca Vicente

INTRODUCTION

Until the middle of the present century, low input agriculture has been the predominant style found in most regions and countries. At that time, several circumstances triggered the development of a generalized tendency toward high input agriculture. Among them, there is the development of the agricultural sciences and technology as well as the industrial technology which produce a wide spectrum of tools, machinery, implements, chemical products and plant and animal varieties. The wide technological offer, together with the demand for agricultural products, the existance of a large area of high potential ecosystems, as well as the favorable situation of prices of agricultural products and inputs, are some of the main causes that lead to the present situation.

Presently, the need of low input agriculture has to be stated in a different context, since the technological offer surpasses the requirements and possibilities of use. There is a political, economical, social, geographical and ecological need to develop low input agriculture in the European Union. The low input agriculture could partially be justified and developed from an ecological point of view.

This paper has been divided into four parts. In the first, the theoretical basis of low input agriculture are presented in relation to the background and the conceptual framework. In the second part, the low input agriculture is described through the main variables which describe it as well as presenting the geographical distribution. The third part refers to farming in the context of diversity and multiple use. Low input can't be justified in the sole context of agriculture and countryside; it needs to be related to the society in general and thus the fourth chapter is related to the society-nature relationship.

1. Presented at the Intensive Course on "The role of low input agricultural system in Europe". Hinojosa del Duque, Córdoba, March 7-11, 1994.
2. Professors Escuela Técnica Superior de Ingenieros Agrónomos y de Montes, Universidad de Córdoba, Córdoba.

BASES

Background

From an ecological and developmental perspective of civilization, environment means the set of situations where a creature has to live (Childe, 1954). It doesn't mean only the environmental habitat: wind, heat, cold and moisture, mountain physiographic conditions, lakes, rivers or swamps, but also factors such as the provision of food and the natural enemies. In the case of human beings, it also includes the economic position, religious beliefs, traditions, customs and technology, as well as other human beings.

The same author suggests that prehistory is a continuation of natural history and that there is an analogy between organic evolution and cultural progress. The world history describes the emergence and adaptation of species that allows a better fitness to get food, land and protection which affects its capacity to live and multiple. At the same time the history of mankind, after the evolutionary process in the natural environment, shows him modifying the environment as he creates technologies, industries and economics which have promoted the increase of the species, vindicating the improvements of his options. The customs and norms and prohibitions condensed the human experiences accumulated in relation to his environment, which transmitted through the centuries by social traditions, take the place of the inherited instincts which allow the species survival in the natural ambit where the species evolved.

The nature is the natural ambit where the species evolved; where many of the necessary environmental conditions for the species are fulfilled. Thus, it has been necessary to develop the technology which would allow the proper transformation of nature to fit human needs, in their historical and cultural evolution. One of these technologies is agriculture. Agriculture, operationally can be defined as the artificialization of the ecosystem, originated in the former concepts of Lawes, 1847, meaning to artificilize the nature (Gastó, 1980).

The physical space where the agricultural problems are solved is the farm, which generates different restrictions and thus, it is of specific nature, that is if the same problem is considered in a different context than the one of the farm and the countryside. The farm is the physical space where agriculture takes place. The different interior spaces have different properties and internal connections among them and with the exterior and are controlled in the last instance by man. Because of this, the agricultural activities are different when taken place under different farm restrictions, and that includes both ecosystem and man.

The farm is defined as a space of natural renewable resources internally connected and limited externally, whose final purpose is to make agriculture (Gastó, Armijo and Nava, 1984). The farm is also an organized decision-making unit where agricultural production activities are carried out with the purpose of satisfying the farmers goals (Ruthenberg, 1980). Agriculture is defined as the process to artificialize the ecosystem. The degree of artificialization is the generalized magnitude of difference between the original reference state of the farm ecosystem and its transformed state. The world agriculture in this work is used *sensu lato*, that refers to any natural resource including forest systems, fresh water, crops, grasslands, annual crops, orchards, wildlife, hunting, recreation or any other.

The ecosystem is a set of biotic and abiotic components connected in such a way that they make a unit or whole. There is a farm problem, when the farm ecosystem state doesn't match the state considered as ideal, according to some anthropic criteria. The constraints arising at higher hierarchies, both physical and ecological don't allow the ideal farm state to be reached. Because of this, it is necessary to identify the characteristics of some states close to the ideal that satisfy the restrictions of the higher levels of control such as those of the county, the region or the country. The study to artificialize ecosystems should start from the basic which allow the decision making and the actions required to solve the problems.

Low, according to the Webster Dictionary and in relation to low input agriculture, could have several meanings. In general, low is defined as occurring not far above the ground, floor or base. It can also be defined in relation to the general or average level, which means that it is less than normal. Thus, it is required to understand the meaning of normal.

The ambit where agriculture takes place is the nature represented by the different ecosystems found in each place. What is normal has to be referred to each ecosystem in relation to its limitations and potentialities. The climate, geoform, soil, plant and animal cover are the variables that describe the system levels of reference in order to eventually determine what is normal. The ambit, represented by the ecosystem where the agriculture takes place, has to be valued according to its potential, in categories such as high potential or low potential ecosystems. In this context low takes on a different meaning, indicating something inferior or below an acceptable standard according to the potentialities of the specific ecosystem. Low input, thus has a different value in a high potential ecosystem than in a low potential one (Table 1).

Table 1. Level of input, output and ecosystem potential posibilities of agricultural systems

Level of input	Ecosystem potential	Level of output	Kind
Low	Low	Low	Low input sustainable agriculture. e. g. good range management, good wild life management
Low	Low	High	Extensive agriculture. Non sustainable. e.g. expensive explotation of the amazone forest
High	Low	Low	Intensive agriculture in low potential ecosystem. e.g. expensive agriculture on low potential ecosystems.
High	Low	High	Extensive agriculture. the sustainable output is low because of low ecosystem potential.
Low	High	Low	Extensive agriculture in high potential ecosystem. e.g. under utilized ecosystems.
Low	High	High	Extensive agriculture. Non sustainable.
High	High	Low	Intensive agriculture with low output.
High	High	High	Intensive agriculture in high potential ecosystem. Is the normal where thw social and economic situation allows it.

To input means to insert or supply energy, mass or information to the ecosystem in order to get a certain output or simply to maintain it in a certain state. In this paper low will have the meaning of an absolutely small amount of a specific input.

Traditionally, low input agriculture has been related with low potential ecosystems, where inputs have also been low since the technological receptivity is not as large as in the high potential ecosystem. This is also referred to as extensive agriculture, and it occurs in circumstances such as non-irrigated arid lands, hill country, mountain areas or swamps. In a relative context, this could be considered as a high input agriculture, since the inputs are as high as the potential receptivity of the ecosystem or even larger.

Under the present CAP situation, low input agriculture refers to many different things but especially to high potential ecosystems receiving a relatively small supply of external additions of energy, mass or information, and thus having an output inferior to its potential.

The rise of modern agriculture

Through most of the temperate world, modern farming is capital-intensive and highly technified. It is characterized by high level of mechanization, large inputs of energy in the most varied ways such as mechanized labor, fertilizers, and pesticides and by a relatively small and declining labor force. The output, expressed in yield per unit area or in work efficiency is far in excess of anything achieved in history (Briggs and Courtney, 1991). It will continue with technologies better adapted to the environment, the political context and the institutional development (Osten, 1993).

The emergence of modern farming systems could easily be traced starting from the sixteenth century, but it has its roots from long before, through a continuous evolutionary process. The following items involved should be considered as a whole when characterizing modern agriculture.

a. Technological development. During the middle decades of the present century agricultural development revived, especially with the massive application of the green revolution and the effects of the available technology and the state of peace that followed the Second World War (Winkelmann, 1993). The impulse to agricultural technology was the final step of scientific and technological development which started during the previous century with the experiment stations, research laboratories, industrial revolution and in general, the progress made on the preparation for the war. The technologies developed, according to their effects, could be grouped into two categories: those oriented to intensified agricultural yields through production factors control and those that permitted to increase the labor efficiency (Ortiz-Cañavate, 1993), which are the following:

Mechanization. The most outstanding is the petrol driven tractor. The direct effect of the tractor was to greatly reduce the amount of time and labor needed in agriculture. It also allowed to enlarge the cultivated lands and the cultivation of lands that, until then, were marginal. Tractors also released land originally needed for feeding draft animals. The depth of cultivation and the change in soil structure, erosion and organic matter distribution, could also be important. Cereal harvesting equipment existed before 1930, but during the 1950's the combine machinery was developed and forage and vegetable harvesters were also in use (Hawkins, 1980). Mechanization has also expanded to grain drying and milking, and they have become automated (Briggs and Courtney, 1989).

Plant and animal breeding. The post war period has seen advances in plant breeding to improve yield, grain characteristics, better adjustment to climate and soil and better suited to the needs of the processor and consumer (Borlaugh,1987). These varieties are able to cope with problems of diseases, pest attacks and lodging. The yield potential increases have been estimated in various amounts such as 0.39% per year to 0.84% per year. Animal breeding has also been successful increasing the production of dairy cattle and beef as well as the quality of production in relation to consumer demands. Artificial insemination has been important as well as animal health.

Fertilizers. The quantity of fertilizer applied to crops in the European countries have increased several times since the Second World War (Table 2). Between 1939 and 1975, it increased by sevenfold in Britain. In some countries or regions such as the Netherlands, the amount of fertilizers, after reaching a peak, at the beginning of the 1980's, has later been reduced. Fertilization practices have also changed, especially with the addition of compound fertilizer containing mainly NPK and the decreased use of barnyard manure. Nitrogen increase has been the most outstanding and it accounts for as much as 30% of the output increase or even more (Austin, 1978).

Pesticides. Development of pesticides started during the 1940's with the introduction of DDT and MCPA and were followed by CMPP, dicamba and dichloroprop and the insecticides aldrin, dieldrin and heptachlor. This produced positive effects increasing yields. On the negative side, there are harmful effects of persistant residues. In the 1960's, organophosphate pesticides were developed. The area sprayed increased about 5% per year (Briggs and Courtney, 1991).

TABLE 2. *Nitrogen fertilizers increase in the EU, from 1970 to 1988 (EUROSTAT, 1992)*

Country	Year 1970	1980	1988
		N ton km^{-2}	
B	19.3	22.3	24.5
DK	10.8	14.1	14.7
D	14.9	20.7	20.6
GR	5.1	8.5	10.6
S	2.7	4.4	5.5
F	7.9	11.4	13.3
I	4.9	8.3	7.6
NL	46.1	56.2	46.7
P	2.0	3.8	4.4
UK	12.4	17.7	20.9

Farming practices. As a consequence of improving technology, yields have markedly increased. Between 1952 and 1975 agricultural outputs in the UK rose 60% (Hawkins, 1980), while the crop area was reduced by 6% due to urban development, mining and afforestation (Best, 1981). Output increase has wholely occurred as a result of improvement in yields (Briggs and Courtney, 1991). At the same time the number of workers employed in agriculture has declined (Table 3).

TABLE 3. *Yield evolution of some crops and animal products (CEE, 1993).*

	Germany		France		Italy		Netherland		Belgium	
	1970	1990	1970	1990	1970	1990	1970	1990	1970	1990
Cereals (100 kg/ha^{-1})	33.4	57.9	33.8	60.7	26.9	38.4	37.6	69.3	33.6	59.7
Sugar(100 kg/ha^{-1})	60.2	69.3	67.4	95.1	38.0	55.7	63.2	98.6	61.2	91.2
Raps(100 kg/ha^{-1})	21.8	30.2	17.5	27.8	18.3	24.3	29.1	30.0	24.8	30.0
Milk (kg cow$^{-1)}$	3779	4803	3116	4559	2659	3557	4170	5784	3641	4168
Potatoes(*) (t ha^{-1})	22	29	14	29	9	17	26	37	22	34

(*) The years 1960 and 1985 respectibily

Farm structures. There has been a tendency to racionalize farm shapes; with small farms being amalgamated, and as a consequence, increasing in size. The total number of holders have been reduced in all countries. This is also related with the conversion from animal traction to tractors, thus increasing the field sizes. The hedgerows have been removed in the UK at the rate of 8000 km per year in order to increase the efficiency of hand labor and machinery. Farm buildings have also changed in size and structure (Table 4).

TABLE 4. *Olive orchards in Spain: sites, productivity, inputs and harvest cost (Estimations and personal communications from several sources)*

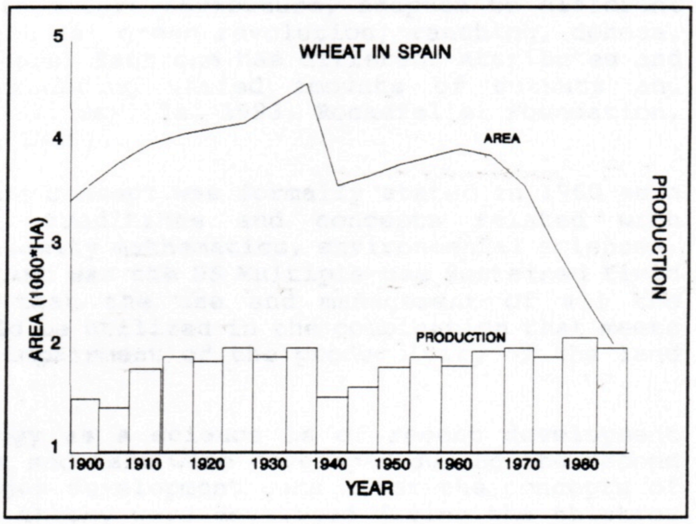
Site kind of land	Fruit Productivity kg/(ha*year)	Kind of Technology and amount of input	Proportion of Cultiveted area	Abandoned orchards % of each class	Harvest cost (pesetas) per kg of fruit
Sierra, thin soils, steep slopes	400	Harvest sligh labor and prunning	High	Very high	40
Sierra, medium soil depth and high slope	1000	Harvest sligh labor and prunning	Very high	High	30
Sierra, medium soil depth and low slope	1500	Harvest sligh labor and prunning	High	insignificant	30
Campiña, deep soils, low slope, dryland	4000	Prunning, fertilizer, weed control, labor	Medium	nil	15
Campiña, deep soils, low slope, irrigated	7000	Prunning, fertilizer, weed control, labor, irrigation	Small	nil	15
Valley, deep soils, flat land, good drainage, medium texture, irrigated	20000	Prunning, fertilizer, mechanized harvest, pesticides, labor, irrigation technified	Very Small	nil	3

b. **Environmental influences.** Farming systems in the temperate world in the kind of crop and activity, as well as in cropping intensity, are based upon similar agricultural principles, using similar farming methods and are constrained by the same factors. They have in common a close relationship with the environment. Yields are no longer so severly limited by the environment: mainly soil and climate. This limitation has been relieved by fertilizer, tillage, irrigation, drainage, herbicides and insecticides. Environment factors influence the yield determining limitations and potentialities. These practices, if continually applied, in the long run could be responsible for negative environmental effects.

In recent decades the increase in productivity has come from increasing yields because of agricultural intensification and not from increasing the area cultivated (Figure 1). Starting from the 1970's there was a tendency that demonstrates that the increase in intensification showing that every year there is a consistent reduction in the increase rate. The agricultural yields of some activities and regions show a tendency to reach a plateau.

c. **Effect of agriculture on environment.** In the long run, it is apparent that high input agriculture damages the environment and underminds its potential productivity. It has been shown that in many cases it damages the soil reducing aggregates stability, increasing erosion risk and deteriorating internal drainage (MAFF, 1970). In some cases high input agriculture increases salinity, reduces fertility, makes soil management difficult and inhibits yields and flexibility of cropping.

FIGURE 1. Evolution of the area and production: wheat in Spain (Aguilar, 1993).



Agricultural technology affects ecosystem and environment in different degrees (Viets, 1977); there are some farming methods which are less damaging as well as have low inputs; however in many cases, they are not significantly less productive. It should be possible to reduce the adverse environmental effects of agriculture without undermining its economical basis. Prices of products are being reduced and also there are incentives to remove land from production, and thus as a consequence, there is an extensification of agriculture by reducing the inputs. One example of this is the conversion in the mediterranean Spain of the high input dryland wheat into wildlife ecosystems farms for hunting. Another example is the abandonment of old olive crops in the high Sierra and the transformation into rangelands. In other cases, the inputs are being increased, transforming into high input systems (Briggs and Courtney, 1991).

d. **Land abandonment.** In areas where the technological receptivity is low, where the ecosystems are fragile and where the output-input relationship is unfavorable, large areas of land are being abandoned. Under the common agricultural policy, those lands are not suited for agriculture. From a global point of view, they are part of the modern agricultural system; and thus cultivated areas are being reduced (Table 4). Extensive areas of low-potential-low input olive orchards are being abandoned as well as cereal crops and dehesas.

e. **Protected natural areas.** Starting from the creation of Yellowstone National Park in 1872 and during the first half of this century, especially until the 1960's, large areas of land have been set aside from crops and animal production as well as other productive uses, and destined for recreation and environmental protection. Land protection through many categories such as national parks, reserves of the biosphere, natural monuments, wildlife refuges, natural areas, natural parks or any other is a style of use, complementary to other agricultural uses (Simon, 1989). Protection could occur, not only in large public areas of land, but also in small areas in private lands such as small forests, meadows, hedgerows or any part o a farm in general (Miller, 1980).

f. **Styles of farming.** Styles of farming concept according with the meaning given in the Netherlands by Ploeg (1992) has the basic premise that wherever its location in time or space, farming always involves the movilization and reproduction of resources, in order to convert them into specific values. It refers to the specific way in which a farm owner or family organizes its agricultural production while establishing differentiated links with markets, technology and natural resources over time. Farming style is connected with specific markets and technologies besides the ambit characteristics. There are numerous styles of farming in modern agricuture, adapted to different situations and personal taste such as: green revolution, ranching, dehesa, organic agriculture, and many others. Each one has different attributes and need of inputs, as well as producing varied amounts of outputs and environmental damage (Altieri, 1987, Sevilla, 1993, Rockefeller Foundation, 1966, Winkelmann, 1993, Hecht,c. 1985).

g. **Multiple-use.** The multiple-use concept was formally stated in 1960 as a result of numerous influences, traditions and concepts related with philosophy, religion, economics, equity mathematics, environmental sciences, sociology and culture. The resultant was the US Multiple-use Sustained Yield act of June, 1960. This means that the use and management of all the renewable surface resources should be utilized in the combination that meets the needs of the people without impairment of the productivity of the land (Lynch, 1992).

h. **Ecological principles.** Ecology as a science is of recent development despite the fact that the concept and term were developed during the second half of the last century. The major development came after the concepts of ecosystem and the general system theory were developed during the thirties and the following decades, especially after the Second World War. Especially during the 1960's, the ecological concepts were introduced into modern agriculture and during the 1970's, the environmental concepts were developed. Modern agriculture has a strong ecological base.

If agriculture is defined in the broad traditional way, which not only includes the different kinds of crops and animal species, but also the forest, the water system, the wildlife, the natural protected areas or any other use, degree or style of artificialization of the natural resources, including those of zero artificialization, the modern agriculture is not only that represented by the intensive cultivation, but also the abandoned areas, the natural protected areas, the intensive crops, the extensive cultivated areas, the multiple-use and the diversity of styles. Everything together is the modern agriculture. In this context, high input agriculture alone, is not modern agriculture because it cannot exist without the rest (Figure 2).

As an example are the forests of Spain. They cover an area of 15.562.000 ha, mostly of low input and low potential ecosystems (Anuario de Estadísticas Agrarias, 1982). Serrada (1994) has calculated that with an additional area of only 500.000 ha of high input in high potential ecosystems, yielding 20 $m^3.ha^{-1}.year^{-1}$ or more would be enough to satisfy the needs. This would be ideal in order to protect the remaining low input-low output forests, developed in low potential ecosystems.

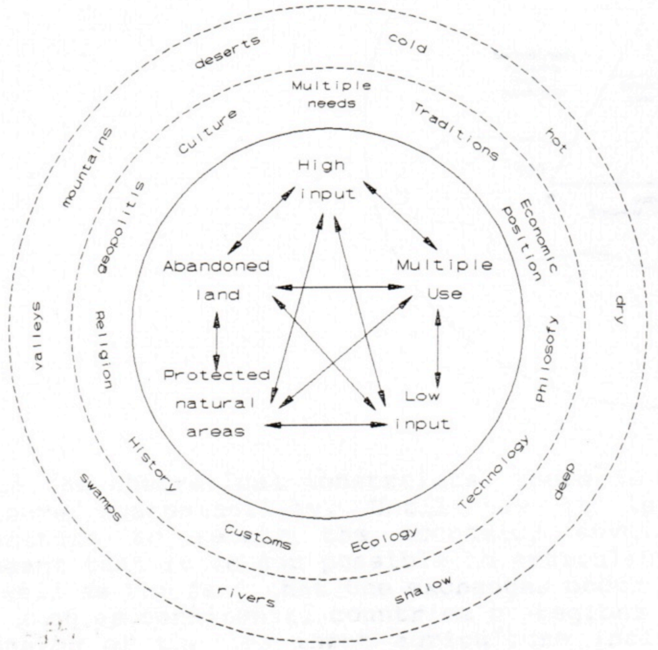


FIGURE 2. Styles of modern agriculture, its roots and the different ambits where modern agriculture takes place.

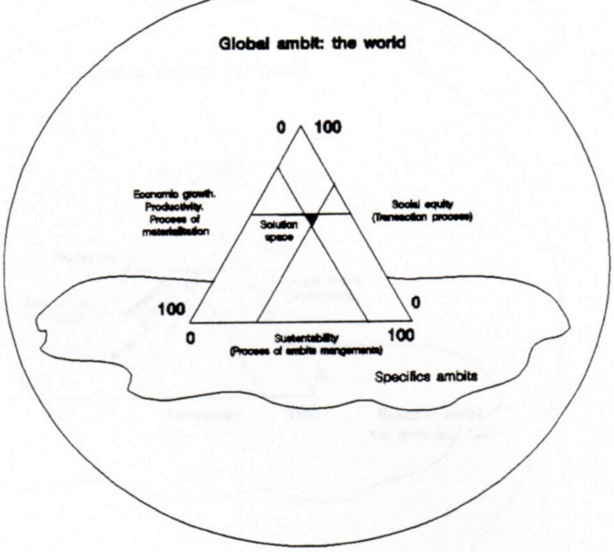
Theoretical framework

In order to be able to evaluate a certain process or activity such as low input agriculture, it is necessary to previously establish the difference that exists between a built model of objectives and the real situation to be evaluated. This means that it is first necessary to describe the reference pattern or desired escenario in order to later establish the differences with the probable expected escenario that will occur under low input agriculture.

The theoretical framework or model, includes three main objectives that according to Nijkamp (1990) would allow a full development: economic growth, social equity and environmental sustentability. These objectives are complementary and mutually exclusive. The ambit where the actions take place are the natural resources, or agricultural environment in general, which differs from place to place, and thus modifying the solution-space created by these three variables. The global change, given by the integration of producers and markets on a European or even world basis, also affects each particular situation and solution (Figure 3).

The model however finds three main kinds of obstacles, of a conceptual, theoretical and practical nature (Dourojeanni, 1991). Among the conceptual constraints, there are several interpretations of development, equity and sustentability. The last one has a meaning of a continuous renovation in time, of the capacity to reutilize the resources by future generations, but it is ambiguous since it is associated with the search of situations to fulfill the present as well as the future generations.

FIGURE 3. *Conflicting and complementary objetives of economic growth, equity and sustainability in agriculture. (Nijkamp, 1990, modified)*



In relation to the theoretical constraints, there is a lack of the proper indicators to measure sustentability. Until now it is difficult to find compatibility parameters to relate the economic, environmental and social objectives. This means that it is not possible to articulate on only one surface the objectives, as well as the fact that the exchanges occur not only in one ambit but between ambits, such as continents, countries or regions within a country. In this way, the expansion of the low input agriculture includes the exchange of technology by natural resources, from a viewpoint of the international fluxes, as well as the landscape transformation and fluxes between ecosystems in the different agricultural sectors, which introduce compensation factors related with the internal deficiencies, which in turn may modify the general objectives. This could be summarized in the lack of possibilities to measure the social, environmental and economic elements under a system of interchangeable values, and also, that such values are different according to the many actors involved.

Finally, the practical constraints related with the establishment of a reference model to evaluate the expansion of low input agriculture in Europe are located in the fact that besides satisfying the three objectives through the productive transformation, generation of social services and natural resource conservation, it should overcome the conflict of interest as well as the mutual changes that will take place, particularly in the short term. This means that the global optimum means the sacrifice of the partial optimum of everyone. The solution space occurs then as a function of the transaction agreements among the different acts and is a transitory agreement that changes permanently according to the technological offer, environmental offer and the needs and aspirations of the different actors.

The Nijkamp triangle points out the main conflicts to be solved to state a reference framework to develop a low input agricultural model, presented under abstract conditions. This model hardly identifies the concrete elements to evaluate and contrast agricultural activities, especially the low input agriculture. However, when the low input agricultural components are analyzed from the many different points of view, it is possible to find the many impacts and possibilities of this style of agriculture.

The solution space permits one to balance productivity with equity and sustainability in a given ambit, both specific and global. It is not always possible, in practical agriculture, to be able to match the theoretical solution with the practical activities. The difference between them is the ecosystem disease (Figure 4). The input intensity given by a low or a high input agriculture moves the real solution to a different position, and thus generates a different kind of disease.

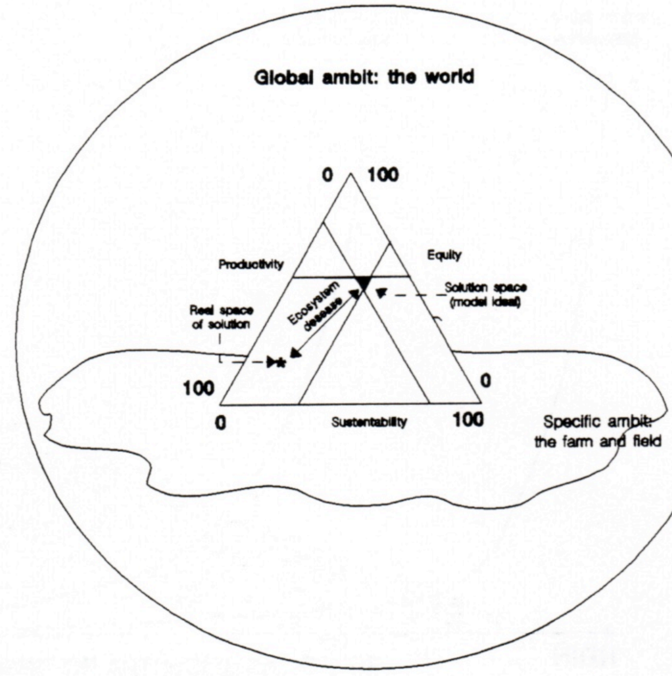


FIGURE 4. Ecosystem disease concept in agriculture: the distance betwen the solution space of the model and the real space solution of agricultural activities; under a given set of conditions of the specific and global ambit.

Sustainability

The artificialization and modifications applied to the original ecosystems where agriculture takes place should be analyzed in the context of real or potential degradation. This degradation affects the sustained yield of those ecosystems, taking them to states different from the optimum and under a destructive tendency, known as ecosystem diseases.

The environmental sustentability refers to the maintainance of positive fluxes balance as well as the capacity to generate medium and large range incomes based on the reproduction, evaluation and conservation of the ecosystem capital (Gastó y Gonzales, 1992). In the case of artificialized ecosystems, mass, energy and information is introduced into the system, as inputs while the parameters of volume (biomass), growth rate, and circulation rate should be kept at those of equilibrium state. The dynamic stability should be capable of maintaining the attributes of harmony and periodicity according to the transformation style. Sustentability has an additional cost in relation to productivity and needs to be added to the productivity costs (Figures 3, 4 and 5).

To determine the sustentability degree for development, five main factors should be considered (Gligo, 1987; Mansvelt and Mulder, 1993).

- -ecological coherence
- -sociostructural stability
- -infrastructural complexity
- -economic-financial stability
- -risk and uncertainty

The ecological coherence is related with the use of the natural resources according to its aptitude. In the long run, to maintain ecological coherence, it is necessary to keep the balance input-output and to have a steady state of the ecosystem architecture and functioning.

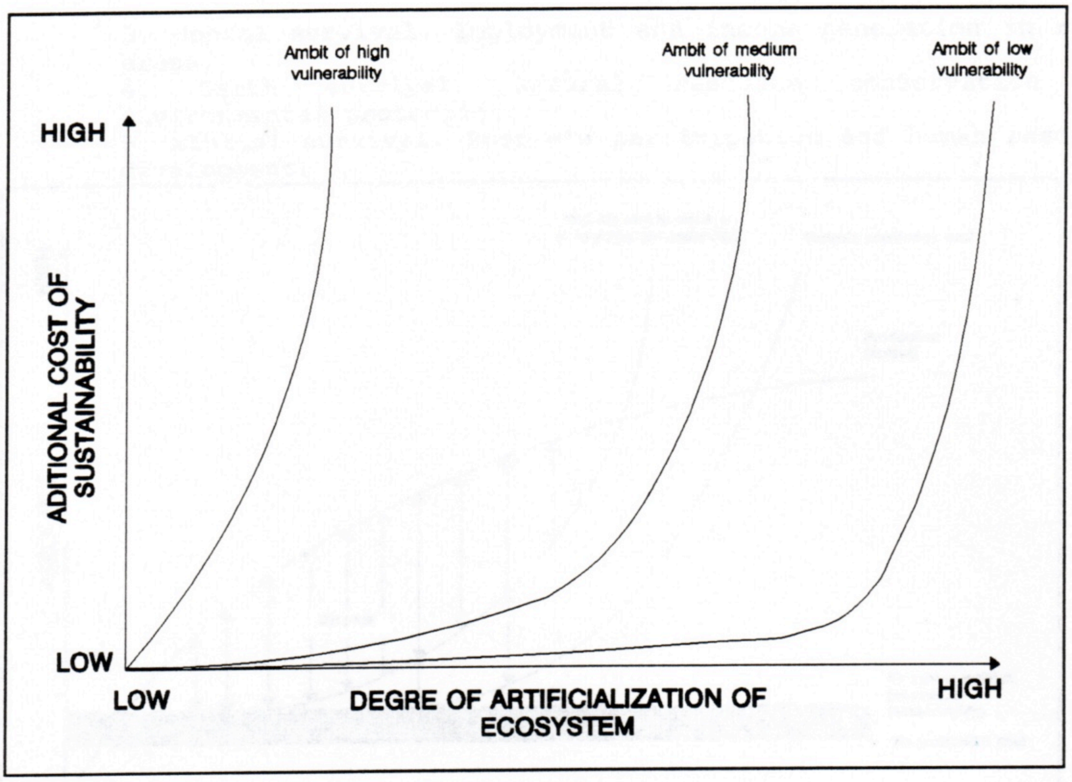


FIGURE 5. *Aditional production cost according to the degree of artificialization in different kinds of ecosystem ambits in relation with vulnerability. (Gastó and González, 1992).*

From an ecological viewpoint, there is a sociostructural action over the biogeostructure, technostructure, surroundings and incident external systems. Such action could generate under conditions of high input, output and harvest, stabilized ecosystems, even when with a degree of artificialization larger than the optimum. The inputs of large amounts of external mass, energy or information (technology) produce high yields, but could lead to an architectural degradation, not allowing a sustained yield (Nava, Armijo and Gastó, 1979). Thus is established a economic, political and social cause-effect relationship between the actors and their ambit. In this way, as much as there exists on a national level, sociostructural stability, low unemployment, low inflation and stability of the macroeconomic variables, it is possible to keep a work market where low input agricutural work-market income are adjusted to the global economic system.

The infrastructural complexity refers to the dependence of the low input systems to generate the intensity of fluxes necessary for the artificialization process of the countryside.

The economic as well as the environmental policies need to be articulated in order to establish a rational use of the resources. The most influencial causes of the environmental sustentability are the price deterioration of agricultural products and the rising prices of the inputs.

Any transformation involves a risk. These risks could be related more with the large infrastructural complexity than with the environmental fragility of the ambit where agriculture takes place:

The main objectives of sustainability could be summerized in (Mansveldt and Mulder, 1993):

1. Human motivations. Basic values and interests of sustainability (FAO, 1992).
2. Physical survival. Food security.

3. Social survival. Employment and income generation in rural areas.
4. Earth survival. Natural resource conservation and environmental protection.
5. Ethical survival. People's participation and human resource development.

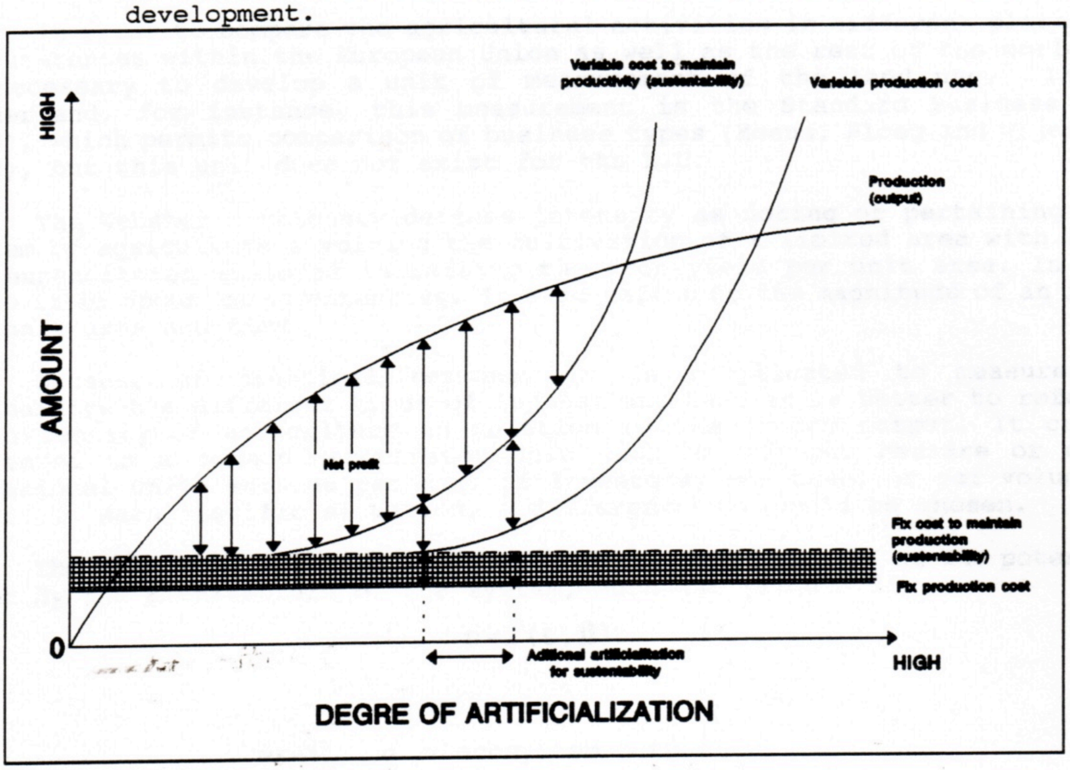


FIGURE 6. *Costs relations, including as a fix cost the environmental control for sustentability. (Gastó & González, 1992).*

The ISEC (Sevilla, 1993) summerizes the basic characteristics guiding the low input agriculture toward sustainability as follows:

1. Main attention is given to the so-called "marginalized" regions and rural social classes.
2. It is considered a learning process; it has a step wise character, and to try to adapt the course of the project to the dynamic needs of the cases studied instead of adjusting the rural reality to the project set-up.
3. The focus is on heterogenity and diversity of farmers instead of on representability.
4. For the last mentioned reason, the work is more qualitative than quantitative.
5. It intends to build upon locally existing agroecosystems and agricultural knowledge.
6. It intends to be build upon locally existing farms of social organization.
7. It starts from a problem definition in a rural context, and tries to avoid an agricultural bias.

Intensity, scale and size

In order to compare the agricultural activities in different places and circumstances within the European Union as well as the rest of the world, it is necessary to develop a unit of measurement of the land use. In the Netherland, for instance, this measurement is the Standard Business Unit (SBU), which permits comparison of business types (Meeus, Ploeg and Wijerman, 1988), but this unit does not exist for the E.U.

The Webster dictionary defines intensity as noting or pertaining to a system of agriculture involving the cultivation of a limited area with labor and expenditures employed in raising the crop yield per unit area. In this sense it is opposite to extensive. It also refers to the magnitude of an input per unit area and time.

Because of practical reasons, it is complicated to measure and standardize the different kinds of inputs, and then it is better to refer to the intensity of agriculture in relation to the system output. It can be expressed in a common denominator unit such as ECU per hectare or other operational units such as per head of livestock, per tree, or per volume of water. In each specific situation, a different unit could be chosen.

The ecosystem output is a function of the input as well as the potential given by the architecture of the system, such as: (Figure 7).

$$\rho = f(\varepsilon, \beta)$$

where: ρ = ecosystem output
ε = input
β = ecosystem behavior, which in turn is a function of its architecture.

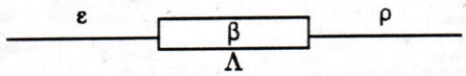


FIGURE 7. Homomorphic model of an ecosystem, given by the input (ε), output (ρ), behaviour (β) and architecture (Λ).

In this context, the intensive production systems is only one of the four cases of high input (Table 1), that is represented by the model high input-high potential-high output. Thus, it should be distinguished from ecological intensification, which includes, besides a high input, the ecosystem artificialization of the ecosystem architecture in order to increase the ecosystem receptivity of technology.

On the other hand, the scale or working scale is the complement to represent a kind of business unit (BU). It could be defined as the ratio between the number of operations and the number of workers. The scale could be expressed, for instance, when it refers to arable land, in hectares per average working unit (ha/AWU), or when referring to livestock, in livestock units per worker (LV/AWV) (Meeus, Ploeg and Wijerman, 1988).

The working scale is mainly a function of the agricultural activity, ecosystem characteristics and kind of technology utilized to accomplish the labor:

$$s=f(A,E,T)$$

where:
A = agricultural activity
E = ecosystem characteristics, and
T = technology utilized.
S = working scale

The business unit efficiency (BUE) could be represented by a system of coordinates described by two variables: intensity and scale. Meeus, Ploeg and Wijerman (1988) present a graph relating both variables in each agricultural region of Europe. There are some areas such as Liguria and Provence which represent high-intensity and small-scale areas, in contrast with Wales, Lorraine, Scotland and Bourgone, with low-intensity and large-scale (Figure 8).

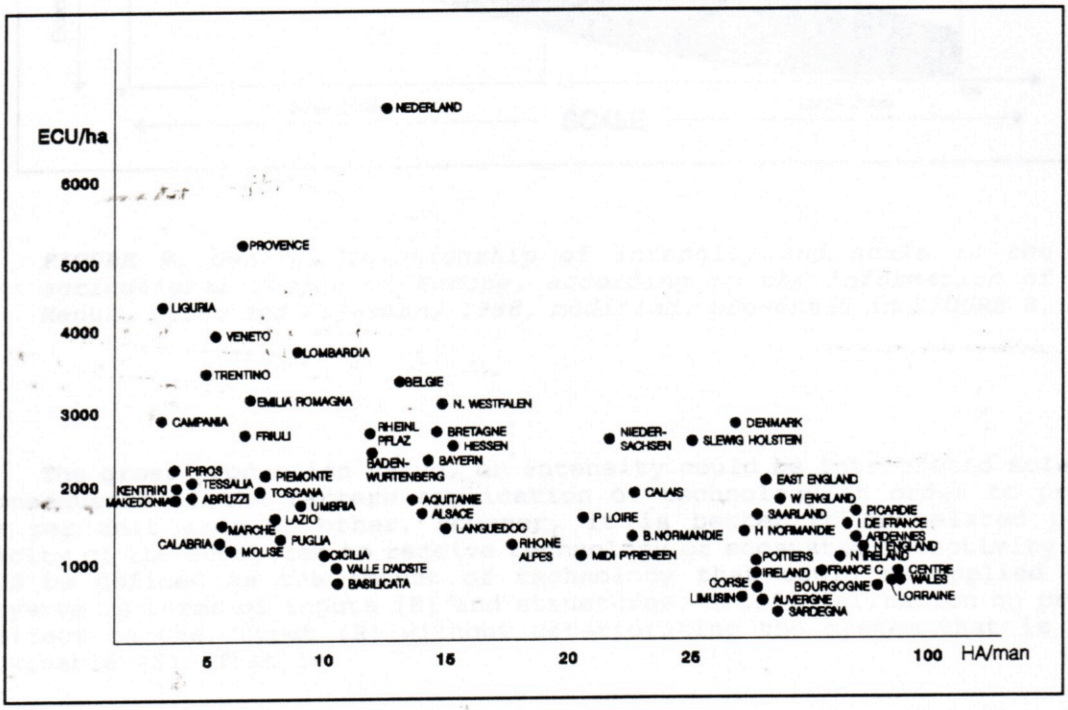


FIGURE 8. Intensity and scale relationship in each agricultural region of European Union (Meuus, Ploeg and Wijerman, 1988)

In this figure, it is clear that some areas of Europe are located in the figure in areas where there is a high-intensity and small-scale, while as the intensity decreases, the scale increases. The low-intensity ecosystems need to be related with large-scale operations, in order to compensate the labor costs in relation to the gross production value,thus the farm needs to be large (FIGURE 9).

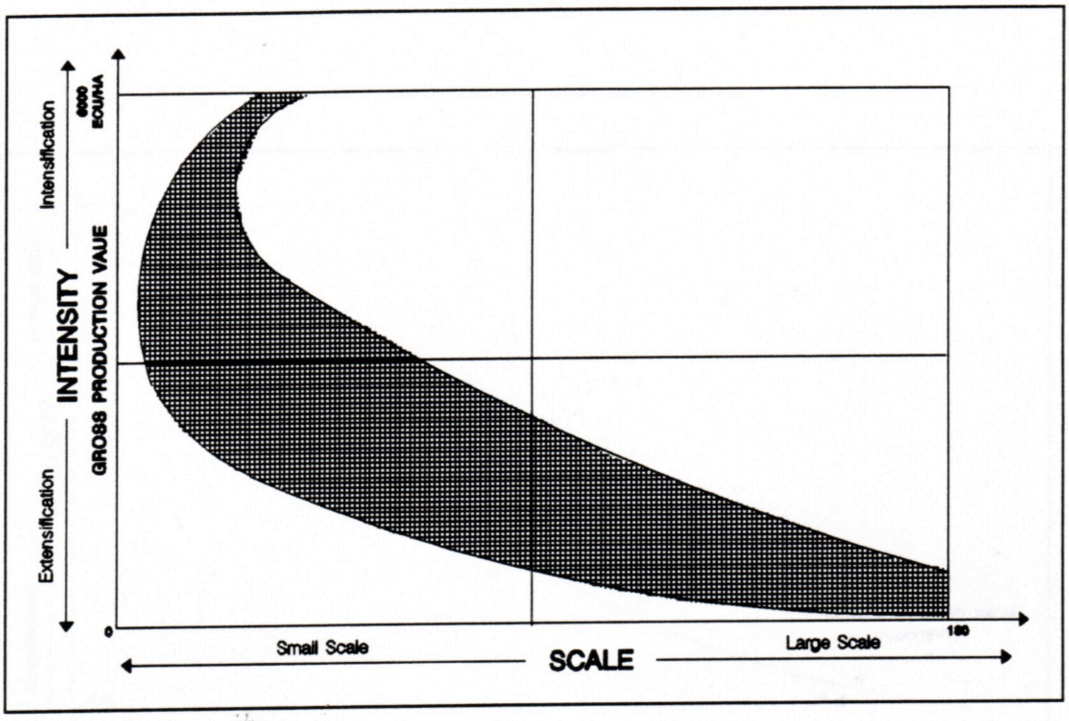


FIGURE 9. General relationship of intensity and scale in the agricultural region of Europe, according to the information of Meuus, Ploeg and Wijerman, 1988, modified, presented in FIGURE 8.

The gross production value, or intensity could be interpreted solely as a consequence of the farmers application of technology in order to produce more per unit area or other. However, it is better to be related to the capacity of the ecosystem to receive technology or ecosystem receptivity. This could be defined as the amount of technology that could be applied to an ecosystem in terms of inputs (E) and structures, artificialization to produce an effect on the output (R) without deteriorating the system that is being sustainable (S). That is:

$$\frac{E}{R}<1.0 \quad \text{and} \quad S=1$$

There are ecosystems which present high technological receptivity and some others that present low receptivity (Figure 8). A good example are the olives in Spain where under sierra conditions the receptivity is very low, in sierra foothills, low, in flatlands, high and in irrigated valleys, very high (Table 4). In the high sierras the erosion potential is very high, the soils are shallow and the response to fertilization, weed control and insecticides is insignificant. This is the reason why these ecosystems are turning into marginal areas. The campiña lands are responding favorable to irrigation and this is the reason why irrigation technology is being widely applied to this area. The irrigated valleys have large receptivity, and thus yields can be very high, as well as sustainable when the available technology is applied. The cost of harvesting the olives is also large in the high sierras and small in the valley.

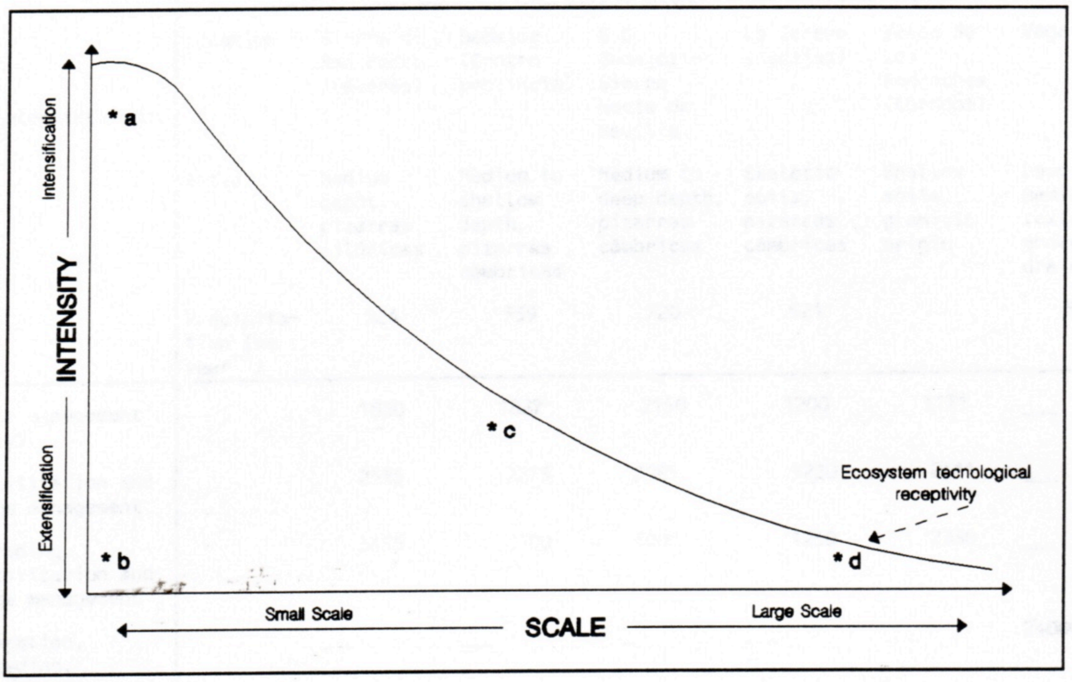


FIGURE 10. General hipotetical of potential technological receptivity of ecosystems arraged from high to law receptivity according to the scale and the real intensity. a: high intensity-small scale; b: low intensity-small scale; c: medium intensity-medium scale; and d: low intensity-large scale.

Another example of technological receptivity is that of rangelands in different areas, that of the mediterranean climate in Spain. The addition of fertilizers let the system express its capacity to produce dry matter under a given set of climatic conditions and a plant cover. Sometimes the productive capacity is limited by the botanical composition of the rangelands and in this case, it is necessary to reseed (Figure 11). If both limiting factors are eliminated, then the site characteristics and climate would start to be the limiting factors. In irrigated lands and deep soils, the productivity would be much larger but this is not the case under rangeland conditions or the best dehesas (Table 5).

TABLE 5. *Rangelands receptivy in different sites of the mediterranean region of Spain when applying fertilizers, reeseding and irrigation as technological inputs, expresed as dry matter productivity (Olea & Paredes, 1980; Muslera & Ratera, 1991).*

Tecnological input	Place and environment						
	Location	Sierra de San Pedro (Cáceres)	Badajoz (Centro provincia)	S.O. Badajoz - Sierra Norte de Sevilla	La Serena (Badajoz)	Valle de Los Pedroches (Córdoba)	Vega(1)
	Sitie	Medium depht, pizarras silúricas	Medium to shallow depth, pizarras cámbricas	Medium to deep depth, pizarras cámbricas	Skeletic soils, pizarras cámbricas	Shallow soils, granitic origin	Deep soils medium texture, moderate drainaje
	Precipitation (mm year^{-1})	524	559	720	521		500
Range management (only)		1850	1887	2150	1200	1171	—
Fertilitation and range management		2585	2275	2985	1220	2411	—
Reeseding, fertilitation and range management		3455	2700	3900	1260	2380	—
Irrigation, reeseding, fertilitation and grassland management		—	—	—	—	—	24000

(1) According to Muslera & Ratera, 1991. The removing information is from Olea & Paredes, 1980.

Site and technological receptivity

The space where agriculture takes place is characterized mainly by its heterogenity given by climate, geomorphology, site and plant and animal cover. This heterogeneous space generates different potentials of technological receptivity since each place differs in its limitations and potentialities. Thus the ecological characteristics of low-input agriculture changes according to the ambit where it takes place (Figures 11 and 12).

The system to classify the ecoregions has nine categories or levels, listed from higher to lower (Gastó, Cosio and Panario, 1993):

1.Kingdom
2.Dominion
3.Province
4.District
5.Site
6.Use
7.Style
8.Condition
9.Tendency

Each category, besides the variable that defines it, is characterized by the remaining ecosystem properties according to its hierarchy level. The Kingdom is the highest category and is classified according to the fundamental zones of Koppen, 1923, 1948. Koppen's system is one of the best known and most widely utilized and has been the starting point of several other classifications such as Thornwaite, 1948, and Emberger, 1942 and De Martone, 1925. The world Kingdoms are tropical, dry, temperate, boreal and nival. The

Dominions correspond to the fundamental type climates and is a sub-division of the former category. It represents the relationship between precipitation and temperature, as well as their seasonal variations.

The tropical Kingdom is divided into three Dominions: rainy (jungle), winterdry (savanna) and seasonal dry (monsonic). The dry Kingdom is divided into two Dominions: desertic (desert) and stepparic (steppe). The temperate climate has four Dominions: summerdry (mediterranean), moist (temperate forest), winterdry(prairie) and seasondry. The boreal Kingdom has three Dominions: moist (park), winterdry (taiga) and seasondry. Finally the nival Kingdom has two Dominions: tundra (tundra) and nival (snow and glaciers).

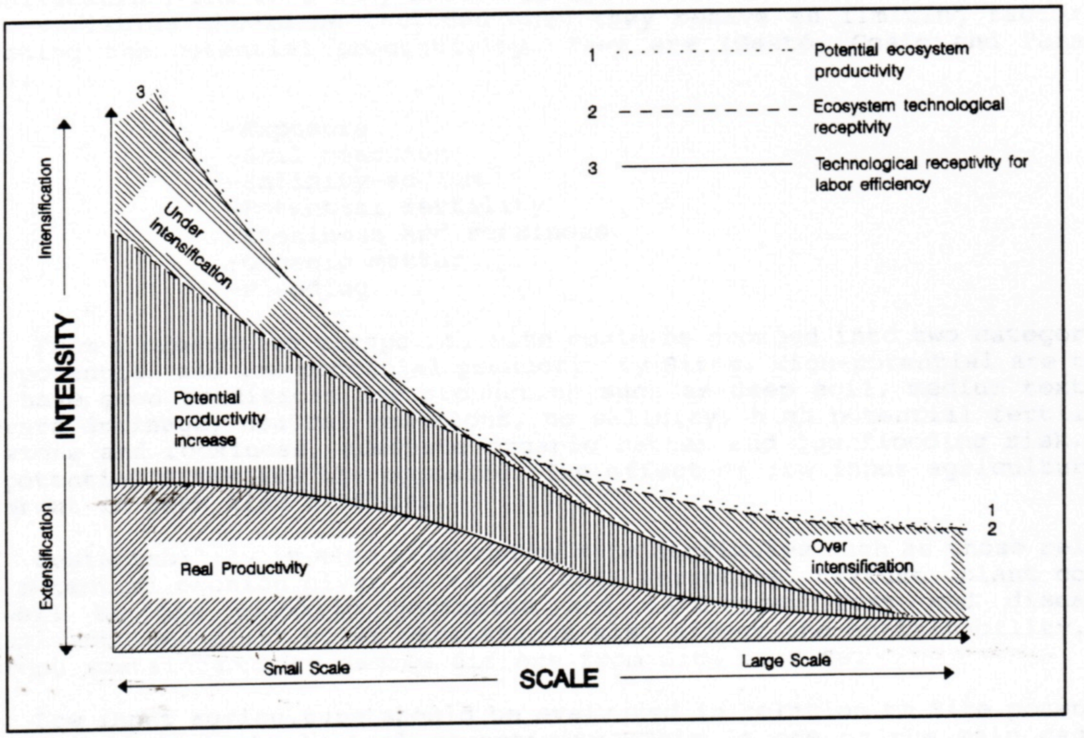


FIGURE 11. Potential ecosystem productivity and technological receptivity curve, according to scale and intensity of the ecosystem.

The Province is the third hierarchy of the system and it corresponds to the climatic varieties and combination alternatives and to the varieties proper to each regional climatic type. The number of Provinces represented in each Dominion varies greatly, as well as their characteristics.

The District is the fourth hierarchy of the system and it is determied by the geomorphy characteristics of each place proposed by Murphy (1967); such as those of the watershed. They are localized in the corresponding Province and are represented on regional working scales. The District classes are five: depressional, flat, ondulate, hilly and montane. The Site is the fifth hierarchy of the system. It is the descriptive unit of management and utilization. The data basis of the geographic information is referred to the Site. The Site is a kind of land different from others in its potential capacity to produce a certain amount and quality of vegetation (Dyksterhuis, 1949; Soil Conservation Service, 1962). The Site is a land area with a certain combination of edaphic, climatic and topographic factors, significantly different from other areas (Society for Range Management, 1974). The ecological description of the farm, county or ambit in general is made at the Site level.

Under ideal climate situation, the Site could be characterized by the natural vevetation that covers it. The most frequent, however, is the lack of vegetation or its modification because of human activities or natural catastrophes. Because of this, Site should be defined not only by the most outstanding features, but also by the most permanent ones. Besides the higher categories of Kingdom, Dominion, Province, related with climate, and District, relative to geoform, the main attributes relative to Site are:

-Texture-depth and
-Hydromorphism

These two have the higher persistence and hierarchy in relation to Site classification, and thus they should always be considered. Besides these two, other variables should be included when they behave as limiting factors or affecting the potential productivity. They are (Gastó, Cosio and Panario, 1993):

-Exposure
-Soil reaction
-Salinity-sodium
-Potential fertility
-Stoniness and rockiness
-Organic matter
-Flooding

From a productive viewpoint, Site could be grouped into two categories: high-potential and low-potential productivity Sites. High-potential are those that have good conditions for production such as deep soil, medium texture, moderate drainage, neutral reactions, no salinity, high potential fertility, low stone and rockiness, adequate organic matter and low flooding risk. The low potential Sites are the opposite. The effect of low input agriculture is different in both kind of Sites.

Sustentability is also affected by Site attributes such as those related with potential erosion given by slope, soil structure, texture, plant cover, as well as the climatic variables and land use. Pest and diseases, contaminants and plant cover persistance also affect the sustainability. The inherent sustaintability degree differs from Site to Site.

Low input agriculture should be evaluated in relation to Site potential as a measure of technological receptivity. This is one of the main causes, besides the size of the region which causes marginalization, intensification, extensification, or industrialization; in other words, regionalization. Low-input style of agriculture from a Site potential viewpoint is not only the cause of regionalization, but also the effect.

Global tendencies

The global tendencies of changing scale and intensity in the EU are represented in figure 13 . There are two extreme situations, one represented by a change of intensity with the scale remaining constant. The opposite is a change from small-scale to large-scale, with the intensity remaining constant.

The scale and intensity are related through the formation of income, through the increase in production per area or through the increase in worker efficiency expressed in area per worker. The combination of both represents the income per worker. Thus when the changes occur there are four different situations that could arise (Figure 14). When the increment of the working scale, as well as intensification can't satisfy the farmers income in a certain region, then marginalization occurs. This means that agriculture is left outside the solution space. There are two situations where marginalization is produced; one is when the inputs applied to the system don't satisfy the costs and the other is when the technology applied is not enough to increment the necessary working scale.

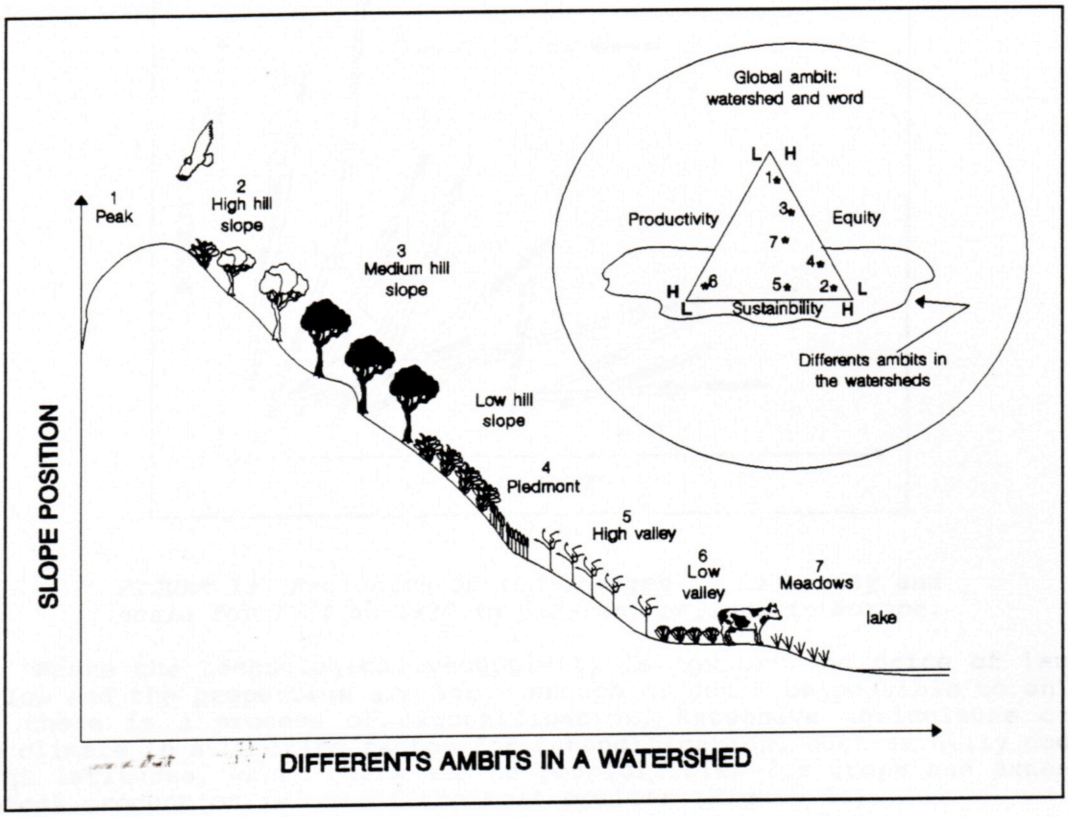


FIGURE 12. *Generalized ideal description of a watershed representing the different specific ambits found on it relation to the location of the solution point in the model. Each watershed ambit and style of agriculture has a different solution space in the model. The location of the spaces are only schematic, they don't indicate the ideal solution.*

In mountain ecosystems, the technological receptivity is normally low, since the input-output relationship reaches 1 at low values of input, and reaches less than 1 when the inputs increase. Because of land slope, the systems are easily erodable and degradable; thus at low levels of technological input, the ecosystems are normally non-sustainable. This means marginality. This is a common situation in the Sierras of Spain, in areas normally cultivated by olives and almonds, where the technological receptivity is low, as well as the sustainability, and where the property size is small and the land price is high, far above the possibilities to increase the scale in order to satisfy the hand labor income requirements.

A common situation is the intensification of small scale agriculture in areas of high technological receptivity. This occurs in the best climates and soils in Europe such as valleys and deep, flat soils, where the conditions to reach high yields of valuable goods are combined.

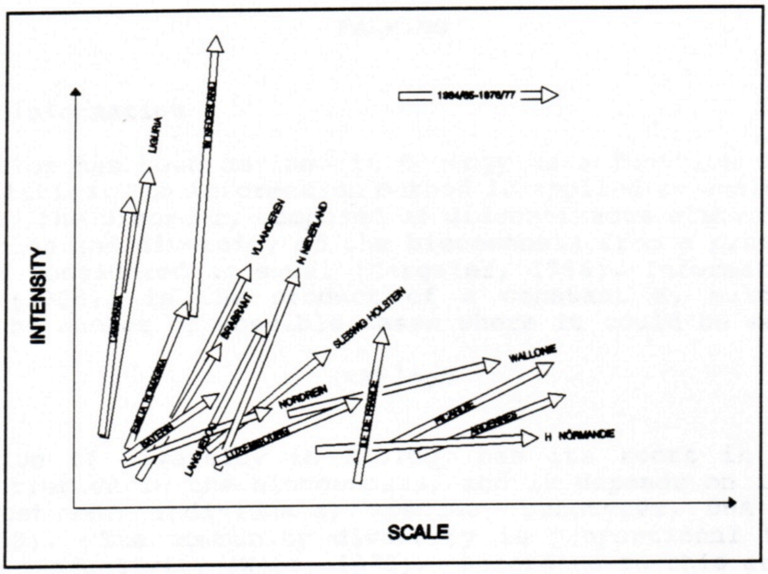


FIGURE 13. Evolution of the changes in intensity and scale for 1964 to 1977 in diferent regions in Europe.

Where the technological receptivity is low but the price of land is also low and the properties are large enough or could be possible to enlarge them, there is a process of extensification. Extensive agriculture occurs where climate is a limiting factor for intensification, such as hilly country in high latitudes, where there are no possibilities for crops and extensive livestock production is one of the best options (Figure 14).

		SCALE. HA/AWU	
		SMALL SCALE	LARGE SCALE
INTENSITY GPU/HA	EXTENSIVE	MARGINALITATION	EXTENSIFICATION
	INTENSIVE	INTENSIFICATON	INDUSTRALIZATION

FIGURE 14. Contingency table of intensity and scale posibilities of agriculture. (Meuus, Ploeg & Wijerman, 1988).

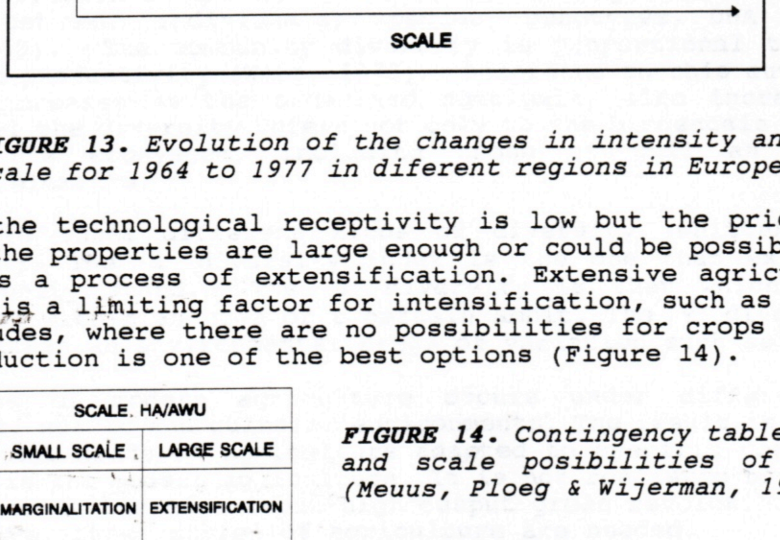


FIGURE 15. Schematic representation of the general tendencies and posibilities of change of scale and intensity.

FARMING

Diversity and information

Information has been defined in Ecology as a function of the quotient of the probabilities. The information method is applied to evaluate the system organization or the disorder, composed of discontinuous elements in space and time. Information and diversity of the biocoenosis from a practical point of view should be considered as equal (Margalef, 1958). Information, according to Brillouin (1956), is the product of a constant K, multiplied by the logarithm of the number of possible cases where it could be selected:

$$I=K*logN$$

The notion of diversity in Ecology has its roots in the number of species and varieties in the biocoenosis, and it depends on its capacity to discriminate between: individuals, species, genotypes, DNA classes, etc. (Margalef, 1969). The community diversity is proportional to the biomass divided by the productivity (Watt, 1973). According to this author, a system efficiency, increases as the organized complexity also increases. At an ecosystem level the diversity refers not only to the biocenosis but to all the elements of the ecosystem, including those of soil as well as the technological elements.

There are three different kinds of diversity (Whittaker, 1960 and McIntosh, 1967). The α diversity index is the one that exists within a definite community stand. The β diversity is that which occurs at a different stand within an area of a certain ambit. The γ diversity is that that occurs within an environmental range of variation such as a watershed.

The rise of modern agriculture occurs under different climatic, geomorphologic, edafic and cultural environments. The result is a combination of many different kinds of agriculture adapted to specific conditions. This set of styles is the modern agriculture. It is not realistic to consider only one of them such as the high input-high output green revolution agriculture, since to survive, other styles of agriculture are needed.

The development of low input agriculture by itself is far from realistic, since it needs to be combined with high input-high output agriculture in order to satify the needs of food for the population. Besides that, it is necessary to have natural protected areas for recreation and for generating mechanisms of stability as well as range and forest reserves to produce the water yields for irrigation and land for wildlife refuge. It is also necessary to develop protection areas and places to eliminate wastes and recycle water. In this context, modern agriculture is a highly diverse and organized mixture of styles and uses, under different ambits all of which give a high β and γ diversity.

One agricultural style is in conflict with other styles and also complements each other. The valley intregates with the mountains in terms such as water yield-water consumption as in terms of different kinds of use, yield, seasonality and work.

Multiple-use

The multiple-use principle is based upon two basic postulates:
a. There are multiple kinds of agricultural environments and ecosystems, each one differs in their limitations, constraints and potentialities.
b. There are multiple needs of the population that can be satisfied through agricultural land use and productivity.

The multiple-use principle means the management of all the various renewable surface resources so that they are utilized in the combination that best meet the needs of the people; making the most judicious use of the land for all of the resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to the changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources each with the other without inpairment of the productivity of the land with consideration being given to the relative value of the resources, and not necessarily to the combination of uses that will give the greatest monetary return for the greatest unit output (Multiple-use sustained yield act, 1960).

Low input agriculture needs to be developed for the multiple-use of land. It doesn't come alone. There are some kinds of land that are better suited for low input and others for high input, and at the same time some lands are better adapted for protection and others for production. To increase the area used by low input, it is also necessary to increase the input of high potential areas, in order to compensate for the needs of the population.

Low input doesn't only mean a reduction of the inputs, it also means the change of inputs as well as the change of uses. A high potential system under the present agricultural conditions, sometimes doesn't work well just reducing the intensity by lowering the input. It is also necessary to change the kind of use; for instance. if it is producing high input cereals, it could change to a cultivated forest.

The multiple-use principle has roots, such as the bibical world view with God, nature and man identifying mankind as a manager and protector of nature. The philosophers view are the results of their reasoning and emotional thoughts. The philosophy views became the origin of conservation in the 1900's and can be summarized, as follows:

1.The biblical view with the need of man to be reconciled with his creator and creation.
2.The enlightment view that states that man can reason the environmental and social dilemas by the scientific method alone.
3.The romanticist view, that our relationship with nature should become more natural.
4.The humanistic view that self is the most important.

Currently, other ideas have joined these views: theory of evolution, eastern mysticist, secular humanism and materialism (Lynch, 1992; Shaeffer, 1976).

During the last decades, several scientific methods and techniques have been developed and applied to solve these problems:
- -Economics. The primary concern of economics is the satisfaction of the unlimited human wants from the finite amount of resources, which includes: efficiency and equity.
- -System analysis. It is an attempt to integrate several systems into a new type of thinking, which resulted in the development of mathematical and technological tools to solve the problems such as multicriteria programing.
- -Environmental. The environmental aspects of multiple-use is the central part of the planning effort. It includes: ecological systems and ecological concepts.
- -Social. Multiple-use plans are for people. It is people who plan the action and it is people who will carry out that action. Planning should include the basic understanding of social needs and concerns in subjects such as: social democracy and public participation.
- -Cultural. A society approaches their needs and problems in a way that fits their cultural background (Lynch, 1992).

In order to fully apply the multiple-use concept, it has been necessary to develop and apply other concepts and laws to complement it such as:

Wilderness Act (1964)
Environmental Policy Act (1969)
Forest and Rangelands Renewable Resource Planning Act (1974),and
Land Policy and Management Act (1976)

The multiple-use planning, according to Lynch (1992), has evolved during the last four decades in the following way:

1. Total use oriented, 1960's
2. Use oriented, 1970's
3. Output oriented, 1980's and
4. Ecological oriented, 1990's

SOCIETY-NATURE

Godel's indecibility theorem states that any model is explained within another, wider and more general. In an adequate version, in relation to the environmental problems in general, it could be stated as saying that it is impossible to give a complete description of the ecosystem having as the only reference its own ecosystem (Margalef, 1974). In this way, a relationship is established between man problem related with his life quality and the human environment, all of which is the metaproblem. The environment affects his life quality and at the same time, it is affected by it as a byproduct of his activities.

The countryside landscape is stated as a tool to solve the metaproblem, which searches for the solution of the human problems in relation to his natural, artificial and human environment with respect to the relationship urban-rural and rural-rural. It is not only an aesthetic or productivist landscape relationship; it is a humanized relationship of the society with nature in its broad development sense which pretends through landscaping, to uncover both nature and man instead of assailing it, as normally occurs.

The rural landscape production should be solved in a n-dimensional model which includes the relationship society-nature, the definition of the solution-space, the working scale, the multiple-use of land, the environmental and the life quality. For that, it is required to state the problem in the human scale, the one which corresponds to the farm and county and the development of the design principles from an ecological perspective, as well as from society and productivity.

Historically it is possible to distinguish three kinds of relationships society-nature. The first characterizes the operational reply of society when facing nature. The second centers its action in the production and reaches its full development starting from the industrial revolution and reflects the capacity to subordinate the natural processes to the society development. Finally, in the present, the society perceives that the environmental transformations are not independent from the social system, which is expressed in the unbalanced production-nature (Novik, 1982).

These kind of relationships are a consequence of the adopted position of humans as a rational being natural-supranatural, which allows him to distinguish between the human and natural and between the artificial and natural. This dualistic position facing the idea of society-nature operated from the viewpoint of mechanisist-materialism as well as idealism in general. The results of this position express themselves in the divorce of the objective and its results in relation to nature, the protectionism or conservationism of resources without man, the instability of the protected nature and it is believed the interpretation of the environment as an external coating of the social operations is fundamental (Lavanderos, 1993).

The public dialogue about the environment is based in the dicotomy of man against nature. Some people have tried to solve this discussion laying aside virgin lands to be preserved in a state of innocence or limiting the ways man can domesticate nature (Facetas, 1991). In ecology this dualistic thinking is expressed by a lack of capacity to incorporate the exchange relationships of the society in a particular way within which is defined ecosystem organization. This is in contradiction with that that identifies the ecology which are not the organisms themselves, neither the environment itself, but the mutual relationship between them. The center of ecology is not the objects implied but the implication that arise from their interrelationship (Mires, 1990). As much as the relationship turns more complex, it is clear that the denial of the biological character as a determinant in the exchange relationship is only a consequence of the social activities.

The alternative option to dualism is to consider society-nature as a single indivisible unit that integrates itself as a whole, which is the base of the monistic point of view for the system. The Monism is based on the society's interest, its development and improvement in a nature in process of transformation, putting together the two ways of the objective process, the nature and the human activity directed toward a goal (Novik, 1982).

The two components of this unit, the society and the nature are connected through mutual casuality. As a consequence the global state of the system could be evaluated in relationship to the organizational invariability of human beings. This is understood as a principle of "homofundamentalism" or "racional anthropocentrism". Any change or transformation in the system society-nature should conserve the system organization under constant conditions in the physical and body structure in the human being, and infinite increase in the information contents as well as the exchange relationship that determines this conservative change (Novik, 1982).

The life quality concept integrates the physical, social and mental well-being of a person and his group (Zumerlinder, 1979) and relates it with his environment. The environmental problems of the society should be analyzed in relation to a reference system, centered around the society and framed in a broader context of problems and metaproblems according to Godel's theorem.

Life quality could be defined as the degree that the members of a human society are satisfying their needs and developing their full potential (CONICYT, 1988). The environment is a basic condition for life quality. It is required, thus, to give a systematic structure and formalize the concept of life quality as well as environmental quality in such a way as to establish objective relationships of the variables that indicate the quality of the exchange society-environment. In this way, concepts such as impact and environmental organization are stability indicators of the system society-nature, according to their resilence and not an ambit without actors on which economic decisions are taken.

The United Nation's Development Program (UNDP) has elaborated an index for the development of human life conditions (IDHC). This index combines three variables: buying power, life expectancy and ability to read.

The buying power is related to the productivity of the natural resources, and it could be sustainable and maintained under the proper conservation and management practice. In this way the deterioration of the natural resources reduces the life quality. The health affects the life expectancy as well as the conditions for life. The life environment is related with the air and water quality and with food, quantity and quality. In this way, environmental and life quality are two sides of the same problem.

The reading ability from an environmental point of view is related with perception. The population has a certain capacity to evaluate and interpret the environment quality signs, exaggerating some and ignoring others. It is necessary to divide reality into two kinds of suffering: the one of nature and the one of man, that finally is only one, the suffering of man.

The search for harmony between society and nature is not only a desire but also a feedback mechanism necessary to compensate the damage relationship of the organized system society-nature (Reganold, Papendick and Parr, 1990). The monistic point of view of the progressive development of the human society and its transformation forces one to reestablish the ecological reconstruction of the technical basis of the society as well as all the matters related with civilization (Novik, 1982).

Agricultural development nowadays should be conceived from the point of view of three main characteristics: organization conservation of the system society-nature, reduction of entropy and sustentability, all being closely related and generating the solution space (Nijkamp, 1990). The growth goals are not necessarily the maximum, according to the ecosystem potential, but the optimum according to the social, energetic, economic and environmental conditions. Very high productivities affect negatively the system to the point where it could lose the organization. Excessive productive growth damages the natural resources and generates economic problems, and because of this, it should be reduced and adjusted to the needs (Constanza, 1991 and EEC, 1991).

The multiple land-use is a modern view of the relationship society-nature. It was formally stated over thirty years ago but has normally been ignored for landscape and farm design. The rural landscape production is a particular case of the multiple-use land use planning at the farm and county scales. The land should be used for the best combination and fitness to the society's needs. It includes, among others, outdoor recreation, rangelands, wood production, wildlife protection, landscape (Lynch, 1992; Green, 1992).

CONCLUDING REMARKS

Presently, the low input agriculture represents a solution to agricultural problems, where the total production surpasses the global demand. In the old days, however, low input agriculture was due to the lack of technological development to achieve and develop a more intensive model.

Agriculture has been evolving from a multiple-activities original situation of the old farms, to an era of specialization and high intensity styles of agriculture, such as has occurred during most of the second half of the present century. However, the rise of modern agriculture has involved simultaneously many by-products and complementary styles, necessary to be able to develop the prevailing high input agriculture such as: abandoned land, organic agriculture and natural protected areas.

The present situation is quite different. Agricultural development takes place where the heterogeneity is well known, as well as the limitations and potentialities of each kind of land. The different population demands are also known. There is also a wide variety of technological offers to satisfy the agricultural and population needs. All of this gives rise to the multiple-use principle. The multiple needs, together with the multiple ambits under an offer of wide technological variety is the basis of the development of the multiple-use style of agriculture. The various styles of low input agriculture is an integral part of the multiple-use principle of land.

There are many styles of low input agriculture. They could be grouped into two categories according to the amount of output:

a. According to the ambit, low input styles are best adapted to low potential ambits.

b. According to the needs, low input could take place in high potential ambits, in order to regulate the amount of output.

According to the purpose of use, under the multiple-use principle, the kind of technology should be adapted to the ambit and the purpose of use such as: production, protection or recreation.

BIBLIOGRAPHY

Aguilar, 1993. Gran Atlas de España. Aguilar S.A. Madrid.

Altieri M.A., 1987. Agroecology: the scientific basis of alternative agriculture. Westview Press, IT Publications. Boulder. pp.227.

Anuario de Estadisticas Agrarias. 1982. Madrid.

Austin, R.B. 1978. Actual and potential yields of wheat and barley in the United Kingdom. ADAS Quarterly Review 29: 76-87.

Best, R.H. 1981. Land use and living space. Methuen. London.

Borlaugh, N.E. 1987. Accomplishment in maize and wheat productivity. In: The future development of maize and wheat in the Third World. CIMMYT. Mexico. D.F.

Briggs, D. and F. Courtney. 1991. Agriculture and environment. Longman Scientific and Technical, Essex, England.

CCE. 1992. Nuestro futuro agrario. Oficina de Publicaciones Oficiales de las Communidades Europeas. CC-73-92-958-ES-e. L-2985. Luxembourg.

Constanza, 1991. Ecological economics: the sciences and management of sustentability. Columbia University Press. N.Y.

Childe, U:G: 1954. Los origenes de la civilización. Breviarios. Fondo de Cultura Económica. Mexico. D.F.

De Martone E. 1925. Traité de geographie. Tome 1. Chapter VI. Tipes de climats. pp 220-231.

Dourojeanni, A. 1991. Procedimientos de gestión para el desarrollo sustentable. ILPES. Documento 89/05 Rev 1. 452 p. Santiago, Chile.

Dyksterhuis, E.J. 1949. Condition and management of rangeland upon quantitative ecology. Journal of Range Management. 2: 104-115.

E.E.C. 1991. Evolución y Futuro de la PAC. Documento de reflexión de la Comisión. COM (91) 100. Bruselas, Febrero. CB-CO-91-004-ES-C;ISBN 92-69 224-3.

Emberger L. 1942. Un project dune classification du climats du point de une phytogeographyque. Soc. Hist. Nat. Toulose. Bull 77: 97-124.

Environmental Policy Act. 1970. National environmental policy act of 1969. 42. U.S.C. 4321 (note). Washington, D.C.

EUROSTAT. 1992. Europa en cifras. Oficina de Publicaciones Oficiales de las Comunidades Europeas. Bruselas.

Facetas. 1991. Hombre y Naturaleza. Washington, D.C. pp 42-48.

FAO. 1992.

Forest and Rangeland Act. 1974. Forest and rangeland renewable resources planning act of 1974. 16 U.S.C. 1601 (note). Washington, D.C.

Gastó J., 1980. Bases ecológicas de la modernización de la agricultura. En Sunkel y N. Gligo. Estilos de desarrollo y medioambiente en América Latina. Fardo de Cultura Económica, México.

Gastó J., Cosio F., Panario D. 1993. Clasificación de Ecorregiones y determinación de Sitio y Condición. Manual de aplicación a municipios y predios rurales. Red de Pastizales Andinos. Quito, Ecuador.

Gastó J., Armijo R., Nava R. 1984. Bases heurísticas del diseño predial. Sistemas en Agricultura 8407. Universidad Católica de Chile. Santiago, Chile.

Gastó, J. and C. Gonzalez. 1992. Interpretación ambiental de la expansión de la agricultura intensiva en Chile: el caso de frutícola. Banco Interamericano de Desarrollo (BID) e Instituto Interamericano de Cooperación para la Agricultura (IICA). Semanario. September, 1992. Washington, D.C.

Gligo, N. 1984. Los factores críticos en la sustentabilidad ambiental del desarrollo agrícola. Revista Comercio Exterior 40: 1135-1142. Mexico.

Green B. 1992. Countryside conservation. E & FN SPON. London.

Hawkins, J.C. 1980. Agricultural engineering. In: Perspectives in world agriculture. Slough; Commonwealth Agricultural Bureau. : 345-366.

Hecht, S. B.c.1985. La evolución del pensamiento agroecológico. Mimeographed. Santiago, Chile.

Köppen W. 1948. Climatología. Fondo de Cultura Económica. Mexico. D.F.

Land Policy Act. 1976. Federal land policy and management act of 1976. 43 U.S.C. 1701 (note). Washington, D.C.

Lawes, J.B. 1847. On agricultural chemistry. J. Roy Agric. Soc. England. 8: 226-260.

Lynch D. 1992. Readings in multiple-use. In: Uso múltiple del territorio, sistemas agrosilvopastorales. ETSIAM-Junta de Andalucía. Córdoba.

MAFF. 1970. Modern farming and the soil. HM50. Agricultural advisory counsel. London.

Mansvelt, J. D. van and Mulder, J. A., 1993. European features for sustainable development. Conference on "New strategies for sustainable rural development". Gödöllö University of Agricultural Sciences. Gödöllö. March 1993.

Margalef, R. 1958. Information theory in ecology. Gen. systems. 3: 36-71.

Margalef, R. 1969.

Margalef, R. 1974. Ecología. Omega. Barcelona.

McIntosh, R.P. 1967. An index of diversity and the relation of certain concepts to diversity. Ecology 48: 392-404.

Meeus, J., J.D. van der Ploeg and M. Wijerman. 1988. Changing agricultural landscape in Europe. IFLA Conference. Rotterdam.

Miller, K. 1980. Planificación de parques nacionales para el ecodesarrollo en Latinoamerica. Fundación para la Ecologia y el Medioambiente (FEPMA), Madrid.

Multiple-use. 1960. Multiple-use sustained-yield act of 1960. 16 U.S.C. 528 (note). Washington, D.C.

Muslera, E. y C. Ratera. 1991. Praderas y forrajes. Mundi-Prensa. Madrid.

Murphy, R. 1967. A spatial classifcatioin of land forms based on both genetic and empirical factors: a revision. Ann. Asoc. Am. Geogr. 57: 185-186.

Nava, R., R. Armijo y J. Gastó. 1979. Ecosistema: la unidad de la naturaleza y el hombre. Universidad A.A.A. Narro. Saltillo, México.

Nijkamp P. 1990. Regional sustainalbe development and natural resource use. World Bank Annual Conference and Development Economics. Washington, D.C.

Novick, I. 1982. Sociedad y Naturaleza. Progreso. Moscou.

Olea, L. and J. Paredes. 1980. Mejora de pastos de secano. Agricultura. 573: 106-109.

Ortiz-Cañavate, J. 1993. Las técnicas agrícolas del futuro: maquinaria, labores y riego. In: Cubero, J.I. and M.T. Moreno. La agricultura del siglo XXI: 213-221. Mundi-Prensa. Madrid.

Osten, A. von der. 1993. El CGIAR: Retos actuales y futuros. In: Cubero, J.I. and M.T. Moreno. Eds. la agricultura del siglo XXI. : 225-242. Mundi-Prensa. Madrid.

Ploeg, J.D. van der. 1992. Styles of farming: an introductory note on concepts and methodology. In: Haan. H. de, and J.D. van der Ploeg (eds), "Endogenous regional development in Europe: theory, method and practice." Proceedings of the I CERES/CAMAR seminar, Universidade de Tras-os-Montes, Vila Real, Portugal. November 4-5, 1991. pp. 1-27.

Reganold, J.P., R.I. Papendick and J.F. Parr. 1990. Sustainable agriculture. Scientific American. pp 112-120.

Rockefeller Foundation. 1966. Program in the agricultural sciences. Annual Report 1965-1966. Rockefeller Foundation. New York.

Ruthenberg, H. 1980. Farming systems in the tropics. Clarendon Press. Oxford.

Serrada, R. 1994. Comunicación personal.

Sevilla, E. et al. 1993. The role of farming system research and extension in guiding low input system toward sustainability: an agroecological aproach for Andalucía. First European Convention on Farming System Research and Extension. Edimburg. 6-9 October 1993.

Shaeffer, F.A. 1976. How should then we live. F.H. Revell Company.

Simon, G. 1989. La relation entre espaces naturels, espaces proteges et a proteger: les termes d'un polemique. In Supervivencia de los espacios naturales. Casa de Velazquez. Secretaría Técnica, Ministerio de Agricultura, Pesca y Alimentación. Madrid.

Society for Range Management, 1974. Glossary of range management terms. Denver, Colorado.

Soil Conservation Service, 1962. Technicians guide to range site, condition, class and recommended stocking rates and soil conservation districts. U.S. Dept. Agric. Soil Conservation Service. Lincoln, Nebraska.

Soil Conservation Service. 1962. Definitions and observations for soil descriptions. U.S. Dept. Agr. Form of 123. Berkeley, California.

Thornwaite, C.W. 1948. An approach toward a rational classification of climates. Geogr. Rev. 38: 55-94.

Viets, F.G. 1977. A perspective on two centuries of progress in soil fertility and plant nutrition. Soil Science Society of America Journal 41: 242-249.

Watt, K.F. 1973. Principles of environmental science. McGraw-Hill. New York.

Whittaker, R.H. 1960. Vegetation of the Siskiyou Mountains, Oregon and California. Ecol. Manographs 30: 279-338.

Wilderness Act. 1964. Wilderness Act of 1964. 16 U.S.C. 1121 (note). Washington, D.C.

Winkelmann, D.L. 1993. La revolución verde: sus orígenes, repercusiones, críticas y evolución. In: Cubero, J.I. and M.T. Moreno. Eds. La agricultura del siglo XXI. : 35-45. Mundi-Prensa. Madrid.