# Characterization and elements for a definition and an analysis of low input farming system in EU-27

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## ABSTRACT

Development of low input (or lower input, or lower external input) and high efficiency agricultural systems is a priority for the future. This objective requires practice improvements (like nutrient balances, pesticide reduction, renewable energies use, adaptation to climate and soil, green manure, …) and farming system improvements (as crop rotation, legume use, biological control, recycling,…). Definition and assessment of low input/high efficiency systems is a key issue. Different ways exist to define the level of input used at farm scale. For each farming system, it is possible to calculate the level of input used per hectare (intensity) or per quantity of product (efficiency). To analyse the different levels of input used, the link between intensity and efficiency, and the environmental impacts, at farm level, SOLAGRO has developed two methods: PLANETE (energetic balance) and DIALECTE (environmental assessment). Among the results, positive links exist between farming practices and low intensity, like low percentage of maize in the main fodder area in dairy farms or organic practices in general. But regarding to efficiency a great variability exists between farm types and inside an homogenous farm group as well (e.g. : dairy farms). Efficiency is also linked with farmer skills, global coherence of farm management, etc. More data are necessary to explain why a farm can be at the same time a low input and a high efficiency system. A same conclusion is also valid to analyze the potential of green house gas mitigation.

### INTRODUCTION

European agriculture has to solve a new equation. Agriculture has at least to be both productive, environmental friendly and sustainable. Productive agriculture means production of biomass for food, energy and other product (biomaterial for building, …) in a context of an agricultural area decrease and a gain of population. Moreover, the respect of the European environmental programmes (cross-compliance, « Nitrates » Directive, Water Framework Directive, European Soil Strategy, the Birds Directive and the Habitats Directive, Biodiversity Action Plan for Agriculture ) requires a better use and a significant reduction of agricultural inputs. It is a clear objective of the Biodiversity Action Plan for Agriculture : " *To promote and support low-intensive agricultural systems* " (COM(2001) 162 final – Table 2). It is clearly a new challenge for the European agriculture : how maintain a good productivity or improve it with a minimum amount of inputs ? In this context the Low Input Farming Systems (LIFS) could be a credible answer.

### LIFS : DEFINITION AND CONCEPT

LIFS could be define as a way to optimise the management and use of internal production inputs (i.e., on-farm resources) ... and to minimise the use of production inputs (i.e., off-farm resources), such as purchased fertilisers and pesticides, wherever and whenever feasible and practicable, to lower production costs, to avoid pollution of surface and groundwater, to reduce pesticide residues in food, to reduce a farmer's overall risk, and to increase both short- and long- term farm profitability" - (Parr et al. 1990).

The LIFS are a combination between intensity (level of input used per hectare) and efficiency (level of input used per quantity of product). The figure 1 below describes the LIFS concept. The LIFS concept takes into account especially the rare and non-renewable inputs : mineral fertilisers, pesticides, fossil energies (direct or indirect), water, fertile soil area. Some of them are closely linked to environmental damages : nitrogen surplus, pesticide contamination (water pollution and biodiversity loss, human health, soil fertility), green house gas emission, eutrophisation.

**Figure 1.** Extensifivity and efficiency measurement : two indicators to analyze low input farming systems (HIFS : High Input Farming systems, LIFS : Low Input Farming Systems, LEFS : Low Efficiency Farming Systems).

### MATERIAL AND METHODS

To analyse the different levels of input used and the environmental impacts, at farm level, SOLAGRO has developed two methods: PLANETE (energy balance) and DIALECTE (environmental assessment).

PLANETE converts all agricultural inputs and outputs into energy. The figure2 below describes the PLANETE methodology.

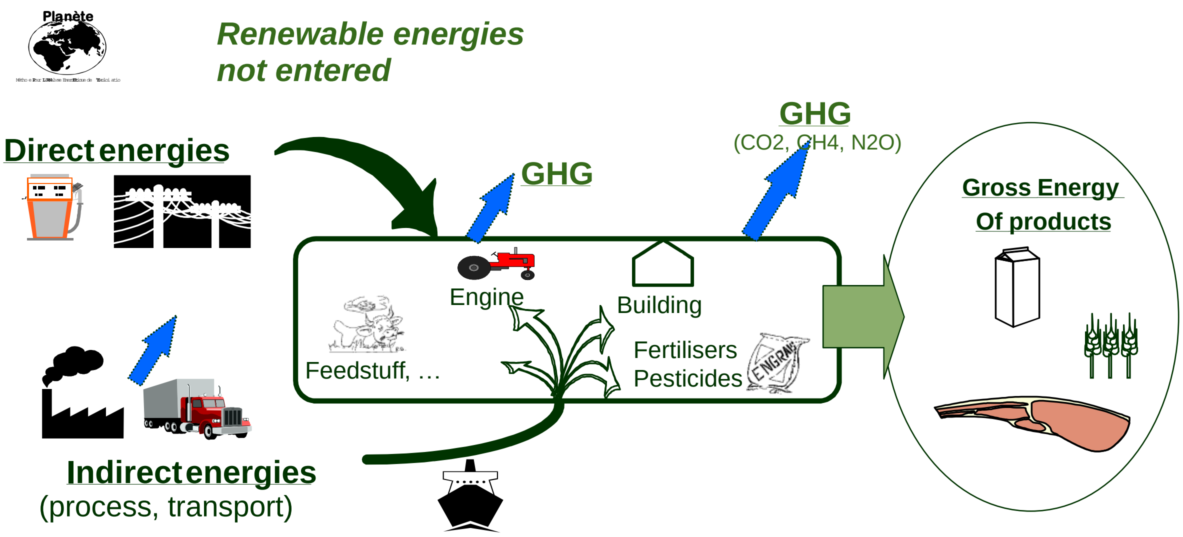


**Figure 2.** The PLANETE methodology

The main results concern the input intensity (energy/ha of UAA, energy / Livestock Unit, …) and input efficiency (energy/litre of milk, energy per ton of dry matter produced, …). PLANETE can also calculate the quantity of greenhouse gas emitted by farm.

PLANETE uses a single unit for all inputs or outputs, the Litre Equivalent of Fuel (LEF) which is more appropriated for the farmers. As an example, see in the table below some inputs converted into LEF.

**Table 1.** List of some agricultural inputs and their energetic value.

| Inputs | Unit | LEF/Unit |
|---|---|---|
| Electricity | kwh | 0,28 |
| Fuel | litre | 1,17 |
| N mineral | Kg N | 1,52 |
| Soya cake | Kg | 0,21 |
| Cereal seeds | Kg | 0,07 |
| Pesticides | Kg | 8,6 |
| Machinery | Kg | 2,4-2,9 |

*(note :1 LEF = 35 MJ = 10 kWh )*

DIALECTE is an overall assessment taking into account the agricultural farming systems and not only practices. DIALECTE indicators contribute to quantitative assessment of the environmental impacts at farm level. The environmental performance is based on an analysis of farm mixity and farming practices (nitrogen management, use of pesticides, irrigation, …). Mixity is represented by crop diversity, breeding and ecological infrastructures. DIALECTE takes into account the impact of a farm on the main environmental components : water (quality and quantity), soil (erosion and fertility), biodiversity and non renewable resource consumption. DIALECTE is also a free data base on internet available to compare environmental results (http://dialecte.solagro.org).

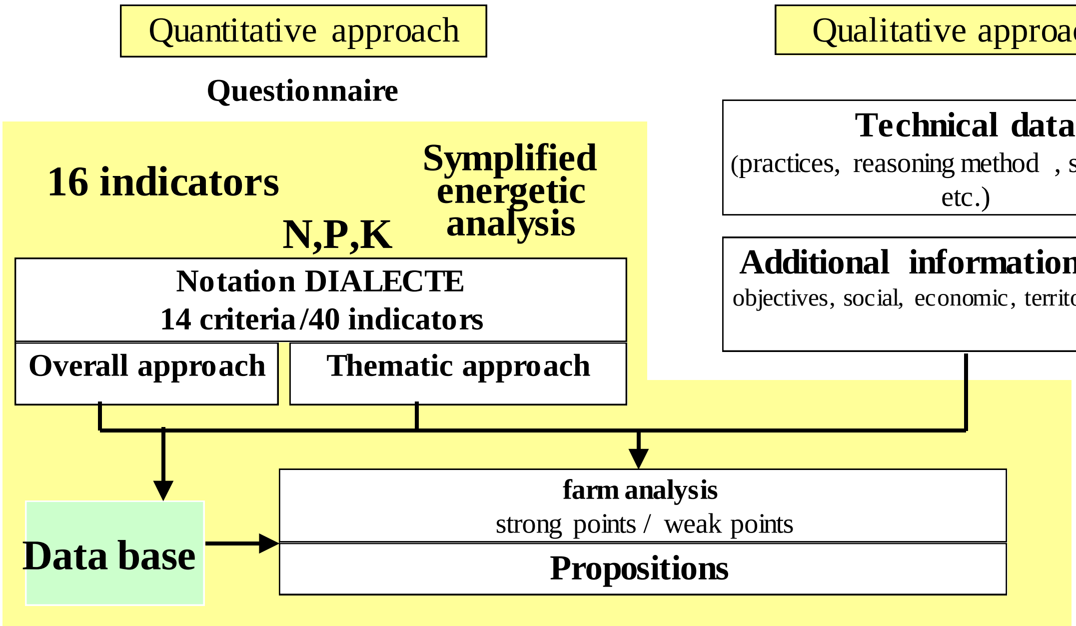


**Figure 3.** DIALECTE methodology

## RESULTS FROM PLANETE METHOD

A sample of 950 French farms have been analysed with PLANETE (Bochu, 2007). All farm types are represented in this sample (dairy Farms with or without marketed crops, crop systems, mixed systems, …). The objectives was to establish a typology of farms regarding energy consumption and energy efficiency.

The average energy consumption is 560 LEF / ha. Four main inputs represent 75 % of the total energy consumed on a farm : fuel for machinery (20 %), feedstuff (21 %), fertilisers (19 %) and electricity (15 %, including irrigation). There is a high variability in this sample and the energy consumption per hectare (intensity) goes from 100 to 10 000 LEF/ha. A high variability can also be found inside a homogenous farm groups (e.g. : specialised dairy farms).

We have analysed a specific homogenous farm group : dairy cattle farms (without marketed crops). On the figure 4 below, 201 farms are compared in terms of intensity (LEF/ ha UAA) and efficiency (LEF/1000 litre of milk). The average intensity is 457 LEF/ha and the average efficiency is 122 LEF to produce 1000 litres of milk.

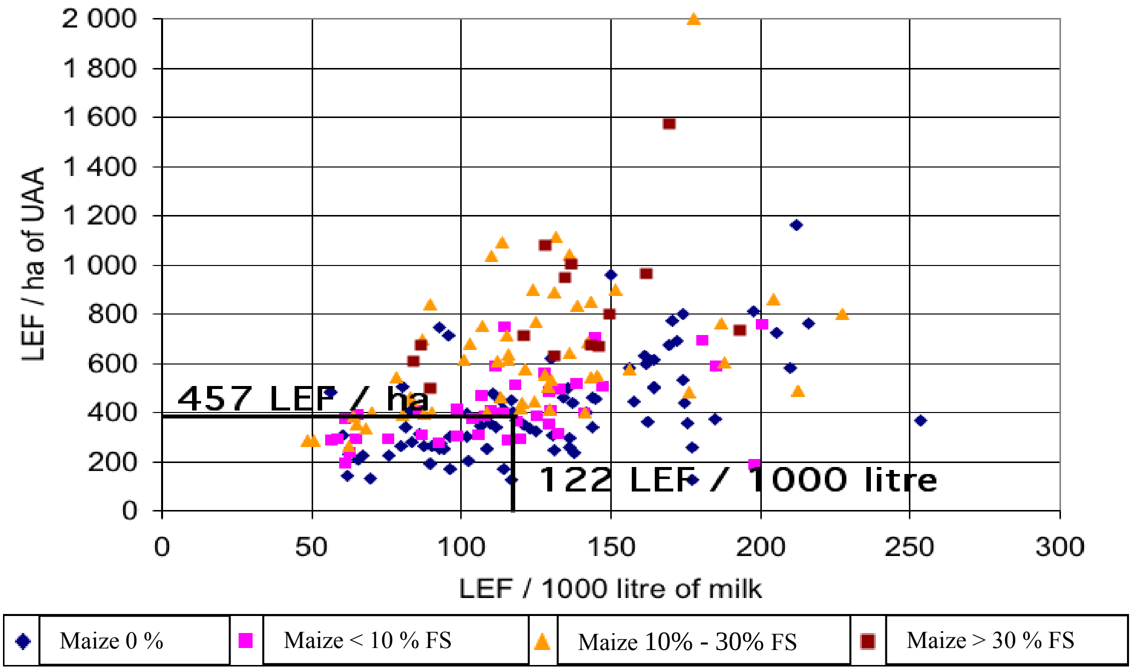


**Figure 4.** Intensity (LEF/ha) and efficiency (LEF/1000 litre) of dairy cattle farms depending of the percentage of maize silage in the main fodder area (source : PLANETE – SOLAGRO)

Figure 4 shows great variability inside this homogenous farm group and the main conclusion is that no simple link exists between intensity and efficiency. Among the low input farms (less than 400 LEF / ha), one part is very efficient (less than 100 LEF / 1000 litres of milk) and an other part shows a low efficiency. The same kind of results is obtained with other homogenous groups. The dairy cattle farm group has also been divided in sub-groups using the percentage of maize in the main fodder area (MFA) as variable. We note a positive link between the percentage of maize and the intensity, but no link is observed between efficiency and percentage of maize.

An other way is to compare farms with different farming practices. On figure 5 below green marks represent organic farms, the pink ones represent sustainable farms and the blue ones represent conventional farms.

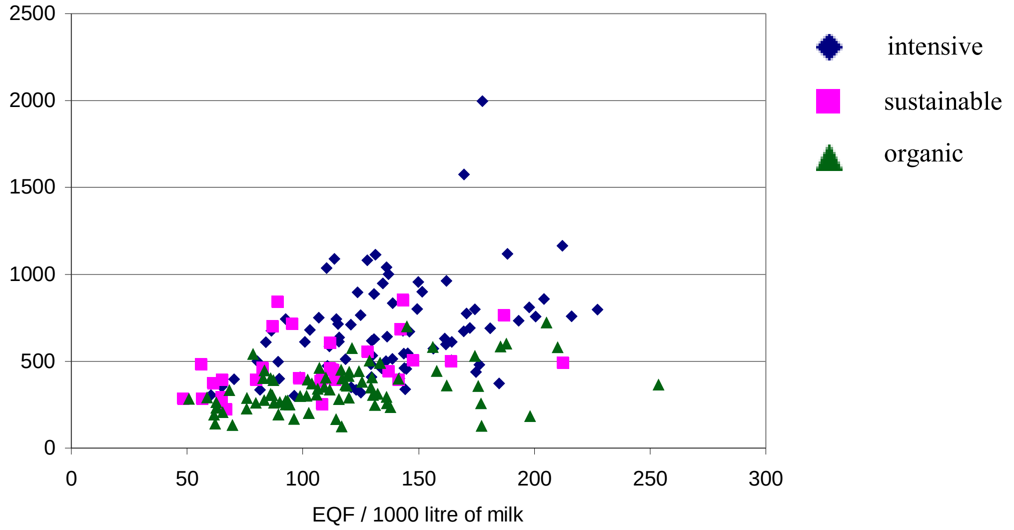


**Figure 5.** Intensity (LEF/ha) and efficiency (LEF/1000 litre of milk) of dairy cow farms with different farming practices : intensive, sustainable, organic (source : Planete – SOLAGRO)

We note a positive link between farming practices and the intensity but no link with efficiency. Organic farms are less intensive.

## RESULTS FROM DIALECTE METHOD

We have compared the environmental efficiency of two dairy cattle systems. The first farm group is a sample of conventional dairy cattle farms and the second group is an organic one. The comparison (see the table 2 below), shows that for the main agro-environmental indicators (crop diversity, share of leguminous, autonomy, percentage of ecological infrastructures in the UAA, nitrogen surplus, energetic intensity and efficiency), the organic farms obtain the best results. It means that organic dairy cattle systems are better adapted to face the environmental challenges (water quality, soil fertility, biodiversity).

**Table 2**. Environmental efficiency of conventional and organic dairy cattle systems (source : DIALECTE data base)

| Indicator | Threshold | **Conventional** | **Organic** |
|---|---|---|---|
| **Mixity of the farm** | | | |
| **Crop diversity and soil coverage** | | | |
| Crop diversity | 10 | 7 | **9** |
| Share of leguminous (% UAA) | 33 % | 13% | **28%** |
| Soil coverage in winter (% UAA) | 100% | 83% | **97%** |
| **Livestock diversity, autonomy** | | | |
| Livestock diversity (number of herds) | 8 | 1 | 1 |
| Fodder autonomy | 100% | 92% | 96% |
| Concentrate autonomy | 100% | 24% | **53%** |
| **Natural infrastructures** | | | |
| Ecological compensation area (% UAA) | 100% | 7% | **18%** |
| Average plot size (maximum 10ha) | | 6 | 7 |
| **Input management** | | | |
| **Nitrogen** | | | |
| N Pressure (mineral and organic) (kg N /ha) | 200 | 139 | 42 |
| N surplus (kg N /ha UAA) | 50 | 81 | **44** |
| **Phosphorus** | | | |
| P Pressure (mineral and organic) (kg P2O5/ha) | 100 | 62 | 22 |
| P surplus (kg P2O5/ha UAA) | 30 | 31 | 6 |
| **Water** | | | |
| Volume (1000 m3) | 150 | 33 | 5 |
| **Pesticides** | | | |
| Pesticides (nb of treatment/ha UAA) | 10 | 1 | 0 |
| **Energy** | | | |
| Consumption (LEF/ha UAA) | 1000 | 630 | **321** |
| Efficiency | | 2 | **2** |

## CONCLUSION

Positive links exist between intensity and some farming practices like the percentage of maize in the main fodder area or organic practices. Organic farming is also a way to preserve environment. But with regards to efficiency a great variability exists between farm types and inside an homogenous farm group as well. Efficiency and environmental impact are mainly linked with the farmer skills and global coherence of the farm. More data are necessary to explain why a farm can be at the same time a low input and a high efficiency farming system. A same conclusion is also valid to analyze the potential of green house gas mitigation.

Develop low input (or lower input, or lower external input) and high efficiency agricultural systems is a priority for the future. This objective requires practice improvements (like nutrient balances, pesticide reduction, renewable energies use, adaptation to the climate and the soil, green manure, …) and farming system improvements (as crop rotation, legume use, intensification of biodiversity, recycling,…) as presentation in the figure 6.

Tools to analyse farming systems must be implemented and statistical environmental data must be improved. More data and references are necessary to precise for each farm types, the thresholds of low input farming systems for each relevant indicators.

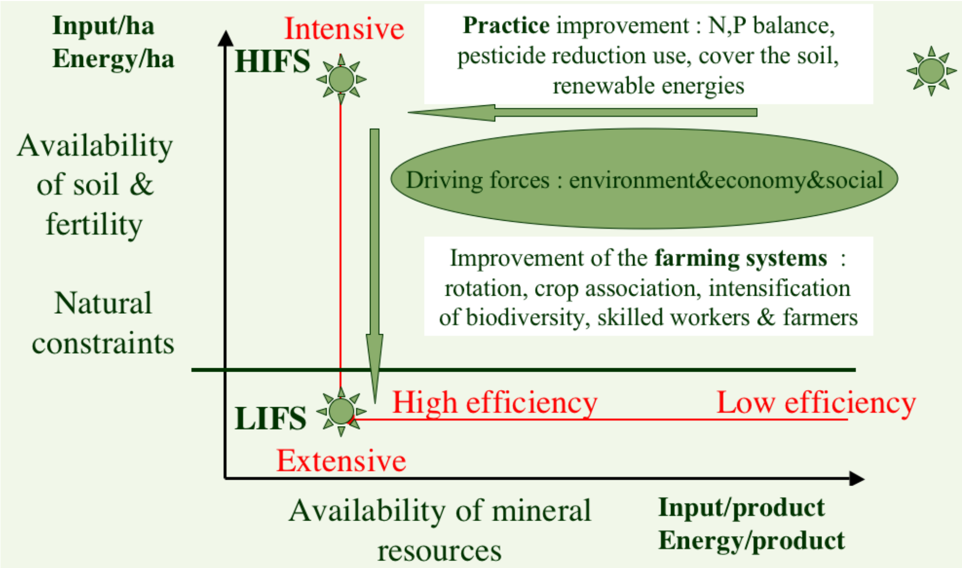


**Figure 6.** Improvement of extensivity and efficiency of farming systems (HIFS : High Input farming systems, LIFS : Low Input Farming Systems)

Current low input and high efficiency systems exist but data are missing to characterize them and explain how they work. One way to improve this analysis will be to create the FEDN: Farm Ecological Data Network to collect and analyze agricultural practices at farm level and input uses (e.g. : natural constraints, farmer skills, rotations, direct drilling, fertiliser rate, grazing period, use of renewable energies, …).

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