Self-assessment to progress

Evaluating cropping systems using objective indicators

In the same way as any other human activity, agriculture increasingly has to assess the sustainability of its practices. How can we evaluate the economic, technical (rotation, product quality) and environmental efficiency of a farm, taking account of the objectives and constraints which characterise it: local area (soil and climate), farm size, human and material resources, and regulatory and commercial environment?

The "cropping system" approach relies on a good description of the important issues and constraints for a farm, in order to understand and study it.

Evaluating a cropping system cannot be confined to the traditional assessment of each task performed for each crop (sowing, fertilisation, treatments...). A study presented at Les Culturales® 2007 (field days organized by ARVALIS) proposes an evaluation method based on the assessment of four farms in the Ile de France region, each characterised by its own approach and constraints. To carry out this study, a series of technical, economic, and environmental indicators was defined.

Within a cropping system, objective indicators are needed to grade the farm from a technical, economic, and environmental point of view

The farms studied

Four farms were involved in the study:

- An "irrigated system" on an average-sized farm with irrigating capacity on 70% of its area, characterised by a drive for maximum profitability through high yields, at the cost of a high working time investment,
- A "high work productivity system" on a large farm, where the objective is speed of work per hectare without sacrificing yield, thus favouring high throughput equipment and technical solutions which require little observation time,
- An "integrated system" on a farm with environmental constraints, aiming to reduce its inputs consumption (crop protection products as well as of mineral fertilisers),
- An "organic farming system" on a farm constrained by its production method and organic farming marketing system.

The crops included in the rotations implemented on the four farms are consistent with the objectives and constraints of their systems,

There are no good or bad systems for all indicators at the same time.

- "irrigated": sugar beet or oilseed rape, soft wheat usable as bread or high protein content wheat, durum wheat, spring barley,
- "high work productivity with no irrigation": oilseed rape, winter soft wheat, spring barley,
- "integrated": peas or oilseed rape, spring durum wheat, winter soft wheat, spring barley,
- "organic farming": lucerne over two years, wheat, spelt, (phacelia in intercropping season), fababeans, wheat, (clover during intercropping season), peas-triticale, wheat under-sown with lucerne.

NB: the prices indicated are an average of prices paid over the last three years (103 €/t for ordinary soft wheat, 213 €/t for organic soft wheat), therefore significantly below current prices in 2007!

The farms studied tend to show positive environmental balances

The need for a global view

The "production system" approach is based on examining the farm as a whole and not as a juxtaposition of practices and concerns without overall consistency. The issues (competitiveness, profitability, and environment protection) and constraints of the farm should not be seen as opposites; instead, they should be considered as the guiding principle behind the farmer's choices, i.e. the best way of summarising information from which to base the choice of crops and cropping techniques.

This approach, validated on real "up and running" farms monitored over several years, gives access to a characterisation of the agricultural activity of a farm taken as whole, technically, economically and environmentally, based on a group of simple indicators. Most of them are already widely used and recognised, others, such as the energy and greenhouse gas indicators, are still being studied and will need to be confirmed. However, we can already say that the four farms involved in the study show satisfactory balances in respect of those new environmental indicators.

Our thanks to the farmer who provided his operating data for the "irrigate" system

Characteristics of the four farming systems *(tab. 1)*

	Irrigation on 70% of farm	High work productivity	Integrated	Organic (5)
Technical indicators				
IVAN (1)(€/ha)	2339	911	1617	1211
Ha/ALU (annual labour unit)	121	380	215	148
working time (2) (h/ha)	7.6	1.8	3.4	6.2
N (kg/ha) on wheat	207	200	153	0
Wheat yield (t/ha)	9.1	8.1	6.9	3.8
Economic indicators				
Wheat gross output (€/ha) (excl. CAP subsidies)	935	835	678	784
Wheat production cost (€/t)	123	114	121	269
Wheat gross margin (€/ha) (excl. CAP subsidies)	629	441	461	680
Farm net margin (€/ha)	345	311	264	367
Input efficiency (gross margin inputs)	2.26	1.04	1.94	13.1
Cropping practices indicators				
Winter soil cover index	50%	58%	56%	75%
Overall nitrogen balance kg N/ha (3)	- 16	23	11	- 14
Wheat crop TFI (4)	3.78	5.45	2.77	0
Farm TFI	3.50	4.92	3.16	0
Energy consumed (MJ/ha)	12035	9669	9891	4445
Energy produced (MJ/ha) (6)	136072	86937	62140	57675
Balance of CO_2 fixed/emitted (6)	3.28	2.65	2.04	5.59
Irrigated water productivity (kg DM/m^3)	3.28	-	-	-

No extrapolation can be based on the results gathered on the 4 farms. (1) IVAN: machinery investment value as new
2) time spent in field – (3) Balance N inputs - N output – (4) TFI: Treatment frequency index
(5) Without specific subsidies for organic farming - (6) Grain only. Straw not removed from the field

The farm net margin indicator (in €/ha) shows that regardless of the system, all four farms "work" and are profitable in the current farming situation (with CAP subsidies)

The results presented here are those of long-term experiments located in Ile de France (the results of the irrigated system are those of a real farm in the same region).

Indicators used

Three families of indicators were used to evaluate the different cropping systems: technical, economic and environmental.
For example, on the technical side, we can see that the Investment Value as New (value as new of the equipment used, per hectare) is going to be very important for an average-sized farm which uses its own equipment. Conversely, the ha / ALU indicator (number of hectares cultivated by one full time person) is going to be the main indicator in a time consuming system.

Economics

From an economic point of view, calculations were carried out using the Compéti-LIS® tool[1].
We take into account the price of wheat exclusive of CAP subsidies, the cost of wheat production, the gross margin, the farm net margin, and input efficiency. For example, the cost of producing organic wheat is twice as high per tonne. From an net margin point of view, all four farms chosen for the study are profitable in the current production system, including CAP subsidies.

Environment

As for environmental criteria, many parameters were studied, from the winter soil cover index to the global nitrogen balance. Technicians noted that nitrogen balances are all very close (more or less 10-20 units); there is therefore no nitrogen imbalance between the four farms studied.
The Treatment Frequency Index mainly indicates the number of applications and the rate used (expressed as compared with the approved rate). This indicator does however have limitations since it does not take account at all of the environmental risk posed by the products used, or of the rate of active ingredients per hectare.

The four arable farms produce "on average" ten times more potentially usable energy than the amount they consume!

The "energy consumed" indicator is designed to quantify the amount of non-renewable energy consumed directly on the farm (fuel, electricity...) as well as the amount of energy needed to manufacture the equipment and inputs used (indirect energy). In terms of energy efficiency, the interesting point is to link this indicator with the following one, i.e. the amount of energy produced. This is the maximum potential energy contained in the parts of the crop taken off the field, which would be restored during total combustion of those parts (the grain in the case of wheat). The "greenhouse gas" indicator is a ratio between the CO_2 equivalent fixed in the harvested biomass (in the form of organised carbon) and the amount of greenhouse gas emitted by the agricultural practices implemented and the production of the inputs and equipment used.
Finally, the productivity of irrigation water expresses the amount of additional dry matter obtained in the irrigated fields per cubic metre of irrigation water applied. It is expressed in kilos DM/m^3.

The figures obtained through this evaluation, which is limited to four real farms, cannot be considered as reference data, and must be explained and used with caution (table 1). But the study does show, and it is a first, the feasibility of this approach. It emphasises the fact that no system is entirely "good" or "bad" for all the indicators, and, more importantly, that each farm, depending on its production situation and its cropping system, can use additional indicators to self-assess and try to improve in specific areas. Self-assessment is a prerequisite to progress!

(1) Compéti-LIS : ARVALIS' Internet application used to calculate production costs.

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