EVALUATION OF SUNFLOWER AGRO-ECONOMIC PERFORMANCES IN LOW-INPUT CROPPING SYSTEMS (EU REG. 2078/92) OF CENTRAL ITALY*

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Summary

The research of a larger ecocompatibility of cropping systems, according also to the regional production disciplinary measures granting Reg. EU 2078/92, calls for the definition of productive processes with lower employment of external inputs

For such reasons the present study compared four rotations (rot1: sugarbeet - maize - sunflower – winter wheat; rot2: sunflower - winter wheat – cauliflower – tomato and/or watermelon – durum wheat; rot3: sunflower - durum wheat - maize - winter wheat and rot4: sugarbeet - durum wheat - sunflower - winter wheat - set-aside) managed with two growing intensification levels; higher is called Conventional System and referred to usually adopted techniques, lower is named 2078 System and is based on the regional production disciplinary measures granting Reg. EU 2078/92. Both of them were built keeping in mind with all main segments of cropping techniques (soil tillage, fertilisation, weed control, irrigation, etc.).

Obtained results demonstrate that sunflower showed only in sporadic cases some positive responses to larger inputs availability, whereas any unambiguous answer seems to be extractable from the data referring to different crop rotations.

For what regards economic analysis, it can be said that sunflower could represent an important constituent in building up low-input cropping systems considering the economic viability that could be achieved just with a restricted employment of production inputs.

Introduction

The relationship between agriculture and the environment has been a rising problem in the past few years. Environment protection became a basic requirement of future EU agri-environmental measures (Agenda 2000) emphasizing the principles yet defined by the well known Reg. 2078/92 that was adopted as an accompanying measure to the 1992 reform of the Common Agricultural Policy.

The research of a larger sustainability of cropping systems calls for the definition of productive processes featured by a lower and lower employment of external inputs, according also to the regional production disciplinary measures granting Reg. EU 2078/92.

So it is very important to be able to foresee crop response to low-input cropping systems and also interactions that can set up with the kind of crop rotation in which crops are included. In this way one will be able to estimate probable levels of attainable yields and to evaluate economic and agronomical suitability of their introduction into specific cropping systems, so to increase actual possibilities of diffusion and success among farmers.

The authors already discussed the effects of cropping intensification on the productive behaviour of sunflower (Bonari *et al*., 1996), but in the present study the oil crop performances are evaluated in four different crop rotations marked by a progressive reduction of water availability. Spring-sown crops as sunflower, maize and sugarbeet are gradually replaced by crops with lower water requirements (winter crops) in order to simulate also very different environmental conditions and farm managements.

Anyway, studying cropping system as the final outcome of integration among technical management, crops and used input levels, obliges to find effective methodologies for assessing alternative cropping systems performances without neglecting various features involved in agricultural activity.

Materials and methods

For such a reason, a research was carried out in Cesa (Arezzo, Central-Western Italy), in the Regione Toscana (lat. 43° 18’ 07” North long. 11° 49’ 15” East, 244 m on sea level) to evaluate the agronomic and economic competitiveness of cropping systems managed according to EU Reg. 2078/92 compared to conventional practices (Bonari *et al*., 1999a).

The study compared four rotations: a) rot1: sugarbeet - maize - sunflower – winter wheat, with 50% of irrigated surface (for maize and sugarbeet); b) rot2: sunflower - winter wheat – cauliflower – tomato and/or watermelon – durum wheat, in which, even if the amount of irrigated surface is equal to rot1, it was foreseen to include species (vegetables) able to make better use of water availability; c) rot3: sunflower - durum wheat - maize - winter wheat, where irrigated surface was reduced to 25% of crop rotation (only maize); d) rot4: sugarbeet - durum wheat - sunflower - winter wheat - set-aside, which was managed without irrigation.

Each rotation term appeared each year. The experiment was a randomized block design with four replications of about 1500 m^2.

Each rotation was managed with two farming intensification levels: a higher one called Conv-Syst which referred to the input level usually used by farmers in the region, and a lower one,

called 2078-Syst, which markedly reduced the use of inputs, according to the regional production disciplinary measures granting Reg. EU 2078/92.
Conventional and reduced systems were applied to the same rotations, but differed in soil tillage techniques, fertilization levels, pesticide use and irrigation water management.
In the present work, we report detailed techniques only for sunflower (Tab. 1), although the differentiation of input levels was applied to the complete crop rotation.
For that reason it is not possible to separate the effects due to specific farming techniques, but results have to be considered as the univocal consequence of the whole cropping system adoption.

Table 1. Cropping techniques in the two cropping systems.

Techniques	**Conv-Syst**	**2078-Syst**
Tillage	ploughing (40-45 cm)	subsoiling (40 cm)
Fertilization	N 94+26†	N 64+26†
(kg/ha)	P_2O_5 44+46†	P_2O_5 70†
Soil disinfectant	furatiocarb	no
Weed chemical control:		
pre-emergence	oxifluorfen	
post-emergence		pendimetalin+linuron

† at sowing and top dressing

In this paper results of the first four-year period of experimentation (1995-1998) are discussed. Unluckily, in the first two years (1995 and 1996), it was not possible to harvest two of the four replications so statistical processing was made only for the last two years of the trial (1997-1998).
Main physical and chemical characteristics of soils are summarized in Table 2, while in Figure 1 thermo-pluviometric trend referring to the period 1966-1998 is reported.
Economic interpretation of obtained results has been made considering the only direct costs for each crop management; these costs have been estimated on the basis of official prices of firms supplying services (minus a 25% to curtail enterprise's incomes) for machine costs and on actual prices for technical means.
The gross production was calculated by multiplying commercial crop yields by their specific sell prices.
To obtain the total profits, we added the EU income compensatory subsidies for grains, oilseeds and protein crops and, moreover, for low-input systems, the specific subsidiary income (measure A1) according to Reg. EU 2078/92.
Amortization rates of rural housings, management and administration expenses and taxes were not considered in the enterprise's gross income calculus and so they are confused inside calculated values.
All the prices, costs and subsidies are referred to the year 1999, and all balance's voices are average values of the four-year period because there were no evidence of relevant differences among years.

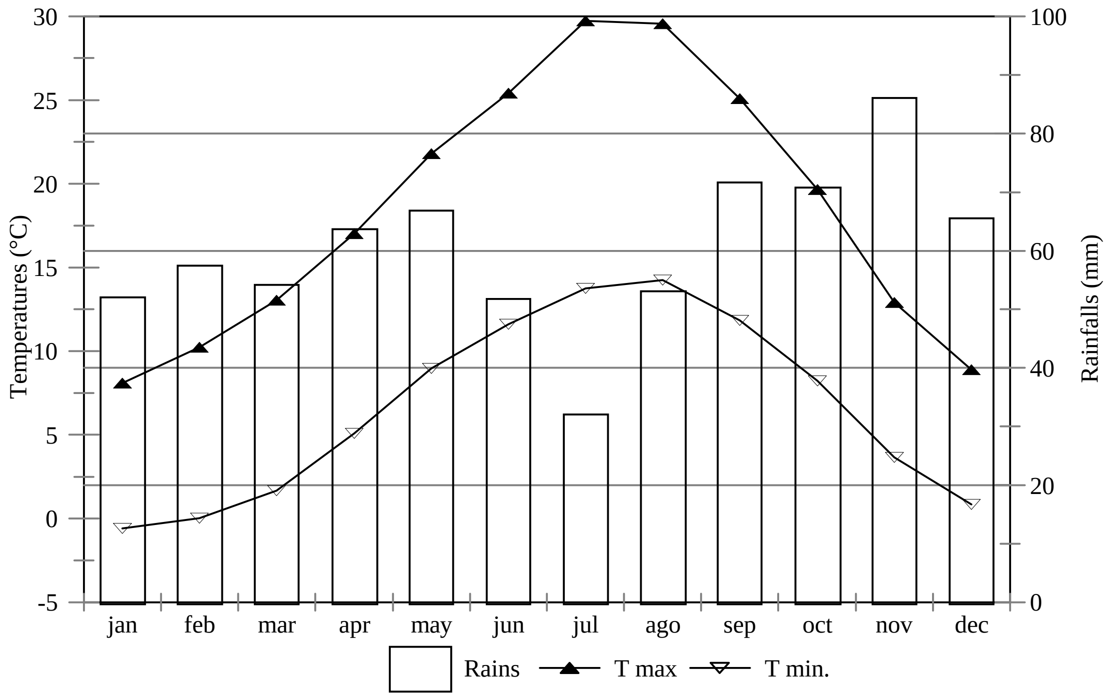
Estimate of balance's voices has been made using a software created by the authors (Bonari *et al*., 1999b).

Table 2. Soil physical and chemical characteristics

Characteristic	Unit	
Sand	%	39.23
Silt	%	26.01
Clay	%	34.75
Organic matter†	%	1.51
Total N ‡	g/kg	0.78
Assimilable P ¶	mg/kg	28.85
Exchangeable K §	mg/kg	136.55
Ca CO_3	%	0.14
CSC	meq/100g	28.87

† Walkley Black method; ‡ Kjeldhal method; ¶ Olsen method; § Method with $BaCl_2$.

Figure 1. Thermo-pluviometric trend of the period 1966-1998



Results

In Table 3 only significant data pointed out by statistical analysis are reported. Sunflower generally showed different responses among the two experimented systems only in the year marked out by a less favourable cropping and meteorological trend (1998); statistically

significant differences were pointed out in favour of 2078-Syst in rotations 1 and 3; on the contrary, in rotation 4, the Conv-Syst allowed to obtain the highest production levels.
Analysing also results registered in the previous years, comparisons are often contradictory (Tab. 4) and the difference registered between the two systems exceeds just 0.1 t/ha of dry achenes.

Table 3. Results of statistical analysis of significant yield data

Year	Rotation	2078-Syst	Conv-Syst	F	p
1998	1	3.76	3.02	11.95	0.04
1998	3	3.29	2.91	103.14	0.00
1998	4	2.48	4.06	155.17	0.00

Table 4. Sunflower yields

Year	rotation 1		rotation 2		rotation 3		rotation 4	
	2078 Syst	Conv Syst	2078 Syst	Conv Syst	2078 Syst	Conv Syst	2078 Syst	Conv Syst
1995	2.04	2.40	2.28	2.25	2.42	2.87	1.59	1.61
1996	2.56	3.02	2.30	2.43	2.11	2.96	2.07	1.67
1997	4.16	3.54	3.32	3.41	3.41	3.72	3.92	3.84
1998	3.76	3.02	3.06	2.96	3.29	2.91	2.48	4.06

The observed differences are to be referred to particular conditions of each year more than to effects due to specific composition of different crop rotations.
Anyway, it could be observed a slight yield reduction (0.4 t/ha of dry achenes) from rotation 1 to 4 : a larger presence of winter grains instead of other crops with higher water demand (maize, sugarbeet and vegetables) would be detrimental for sunflower yields.
Instead, more notable are the differences among years (up to 1.0 t/ha of dry achenes) which are principally to be referred to different amounts and distributions of spring-summer rains as sunflower was never irrigated.
Referring to the economic analysis, it is necessary to state that not taking account of farm constraints (acreages, machinery, permanent labour force, irrigation water availability, etc.) is a severe limitation for an immediate transfer of the experimental results to farmers. On the other side, the opposite choice of considering the specific farm constraints would have made not proposable each attempt to extrapolate any indication.
Anyway, registered differences between the two systems are not negligible (Tab. 5): total four rotations average costs are higher of about 140 euros/ha (+28%) in Conv-Syst; the conventional techniques show primarily a larger incidence (34% versus 28% of 2078-Syst) of technical means costs than mechanical ones. The gross product of the two systems, instead, show a more limited gap (11 euros/ha in favour of Conv-Syst) so that profits are definitely higher in 2078-Syst also because of EU specific subsidiary incomes. So the economic advantage for “2078 techniques” adoption is about 300 euros/ha corresponding to an increase of more than 60%.

On the contrary, the differences pointed out among single rotation results (as average of the four-year period) are more limited : from the lowest gross income (rot3) to the highest (rot1), it can be observed an increase of 100 euros/ha for the Conv-Syst and of 181 euros/ha for 2078-Syst.

Table 5. Economic analysis of conventional and 2078 systems (as average of all rotations and all years).

	2078-Syst	Conv-Syst
machinery costs	377	439
technical costs	148	231
total costs	525	669
gross marketable product	586	597
total profits	1252	1102
gross income	727	432

Conclusions

Once more, the behaviour of sunflower managed with different levels of cropping intensification was uncertain and contradictory. In fact, in diversified rotations, no clear response of sunflower to larger input availability was observed; neither a clear effect due to the kind of rotation was pointed out. The observed variability should be interpreted more in relation with climatic scenarios.

Considering the economic results, the profitability of sunflower was better obtained with a restricted use of production inputs, which makes this crop a valuable candidate for low-input cropping system

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