Impact assessment of the introduction of grain legumes in cereal-based cropping systems in the Midi-Pyrénées region (France) using the modelling chain: APES-FSSIM-Indicators

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In the early 1980s cultivated land planted with grain legumes increased very rapidly in Europe due to specific EU policy to support protein production (premiums, funding of research and extension programs). But with the evolution of the CAP (decoupling and reduction of subsidies per ha) and international commitments (Blair House agreement with consequence of duty-free soybeans importing) the surface area set aside for grain legumes declined substantially by 78% from 1993 to 2008. Recently, several EU regions announced new premiums to boost grain legume crops (1). This paper presents a study using a bio-economic model to assess impacts of the economic incentive measures in the Midi-Pyrenees region (France) on legume introduction in cropping systems by analyzing, at farm level, the farm income and total energy consumption.

Materials and Methods

The APES-FSSIM-Indicators modelling chain developed as part of the SEAMLESS project (2) was used for ex-ante assessment of some impacts of the 2003 CAP reform if maintained until 2013 (reference scenario) and of two alternative scenarios (S1) and (S2) in the Midi-Pyrénées region. Scenario S1 was designed after an expert interview (regional head of agriculture for the Midi-Pyrenees region). It is acknowledged that the crop rotations of rape-wheat-peas-wheat, maize-peas and sunflower-peas, are suitable for the climate and agronomic conditions of the Midi-Pyrénées region. Thus, In S1 scenario rotations including peas were tested. Peas are less economically competitive than most cereal crops; therefore it was assumed that these new crop rotations would not significantly increase pea areas on given farms. Consequently, the S2 scenario is a combination of new crop rotations including peas and three regional recommended levels of current and future supplementary premiums (55€/ ha, 155€/ ha , 180€/ha and 205€/ha) (3). Both scenarios were applied to two representative arable farm types (FT1 and FT2), selected by using the farm typology developed for the SEAMLESS project, defined by 4 criteria: size, intensity, land use and specialisation. The main structural difference between these two farm types is the irrigable land area: 40 ha and 28 ha of total land respectively for FT1 and FT2. The experimental data provided by INRA-Toulouse (France) was used to evaluate the APES model for the main crop rotations including major grain legumes, pea and soybean in the region. The FSSIM model, previously calibrated for FT1 and FT2 (4), was used to simulate these alternative scenarios and to assess farm income and energy consumption (represented as the amount of energy needed to perform all farming operations).

Results and discussions

The S1 scenario slightly increased the pea surface area by 3% and 8% respectively for FT1 and FT2. This result confirms the assumption that without specific subsidies, legume crops are less profitable than cereal crops. However, even though the modification of the pea surface area was very small, we noted a substantial increase of the more profitable sunflower-pea (gross margin of 685€/ha) instead of durum wheat-pea (gross margin of 598€/ha). In the S2 scenario three levels of supplementary premium were tested. With 155€/ha as a premium, the pea surface area increased by 11% and 17% respectively for FT1 and FT2. A similar tendency of

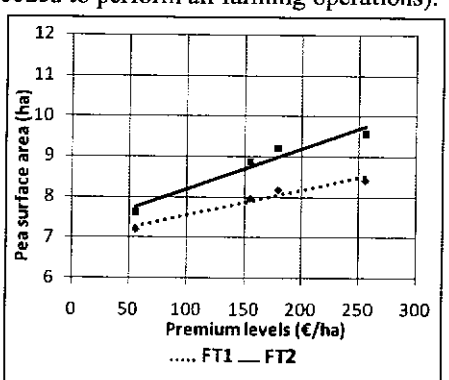

Figure 1 : Response curve for pea surface area to different premium levels for FT1 and FT2.

gradual increase in pea surface area has been observed for premiums of 180€/ha and 205€/ha. Figure 1 shows that the pea surface area in each farm type increases linearly with the allocated premium. Overall, a premium of 166€/ha and 100€/ha is required to increase pea surface area up to 1 ha for FT1 and FT2 respectively. This difference in premium between the two farm types can be explained by the fact that more irrigated area is available in FT1, and that it has more profitable irrigated maize, than in FT2. Thus, FT2 cultivated more rotations including peas than FT1 and therefore needed less premiums to adopt to rotations including peas. Figure 1 also shows that despite the strong correlation between premium levels and the evolution of pea surface area, the increase of pea surface area is very low when the premium
increases (slope less than 0.01ha²/euro). This result confirms that specific premiums are one of the important ways of inciting farmers to grow legume crops but are not enough to significantly increase their cultivation. The low grain legume yield is the second important factor explaining the low legume area. In addition, farmers considered legumes to be very risky crops, compared to cereals, with a high annual variability in yield. A third scenario (S3) combining all the incentive factors, e.g. new legume rotations, premiums, new varieties with a high yield and less annual yield variability are ongoing to test this assumption.

Farm income: For both scenarios (S1 and S2), the farm income remained almost the same compared to the baseline one (baseline =; S1=103369 €; S2=95038 € for FT1 and S1=97284 €; S2=98655 € for FT2). In fact, for the S2 scenario the drop in gross margin (650 €/ha) induced by the decrease of durum wheat and maize under cultivation was compensated by an increase in pea, sunflower and soft wheat under cultivation (gross margin 675€/ha). This result contrasted with the literature in which rotations based on cereal-legume are often less profitable than pure cereal rotations (5).

Total Energy: In the S2 scenario a decrease in energy consumption of 8% and 3% was observed for a premium level of 155€ due to the decrease in irrigated maize surface areas by 10% and 13% and the increase in pea surface area by 11% and 17% respectively for FT1and FT2. A similar tendency of gradual decrease in energy consumption was also observed for premiums of 180€ and 205€. This result confirms the results obtained by UNIP and Arvalis (1), with 2008 figures showing lower energy consumption of 300 liters/ ha for rotations including legume crops than for cereal ones.

Conclusions

These results show that the alternative scenarios (S1, S2) tested did not significantly change pea surface areas on both farms. A similar tendency of small changes in farm income and energy consumption was also observed for both farm types. The results proved that increasing premiums without considering the low pea yield and variability cannot significantly promote legumes in the Midi-Pyrenees region. This methodology can be useful for simulating complex scenarios at farm level. Use of such modelling sequences has some limits with respect to weeds and diseases, which have not been considered. This work shows that further use should be made of this modelling chain for simulating other scenarios including the provision of more premiums for the growing of peas, technical innovations, taxing fuel and fertilizer, better management and combinations of these scenarios.

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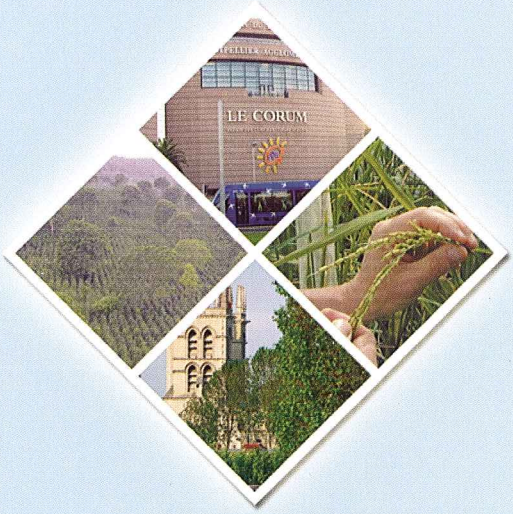

August 29th - September 3rd, 2010
Montpellier, France