THE ECONOMIC SUSTAINABILITY OF AGRI-ENVIRONMENTAL POLICIES: THE APPLICATION OF REG. (EC) N. 1095/2007 IN THE RICE SECTOR

JEL classification: C61, Q18, R14

Anna Gaviglio, Eugenio Demartini, Alberto Pirani*

Abstract. *Positive Mathematical Programming represents a useful tool for agri-environmental policy planning. This paper estimates the consequences of the application of the Regulation (EC) 1095/2007, relating to the ban on the use of the active agent Tricyclazole, which is normally employed to combat rice blast. The main objective is to quantify the variation in farmers' revenues and the change in use of land, in response to variations in the yield of rice produced and its production costs. The research has been focussed on the rice-farming sector in the Parco Agricolo Sud Milano (PASM), a sub-urban agricultural area of the regional capital of Lombardy that, since 1990, has been a protected area and has been under the management of the Province of Milan. The data for the case study was collected in situ and combined with the data from the Agriculture Databank of Lombardy Region considering a sample of farms representative of the rice-farming sector in the PASM. The study present the results of simulations of ten different sce-narios with a view to evaluating the overall sustainability of the cautionary measures introduced.*

Keywords: *Economic Sustainability, Policy Planning, Positive Mathematical Programming, Rice Sector*

1. Introduction

The paper examines the possible effect of a ban on the use of the active agent Tricyclazole in agriculture as foreseen by the Regulation (EC) 1095/2007, in force since the beginning of 2009, in a production area South of Milan. Tricyclazole is a molecule contained in a fungicide utilized for the control of rice blast, an endemic disease which attacks rice, caused by *Pyricularia grisea*. Originally from Asia, it is now widespread and present in 85 countries worldwide (Agarwal *et al.*, 1989; Rao, 1994) and is especially rife in intensive cultivation systems in temperate zones (Kuyek, 2000), as in the zone of the Agricultural Park of South Milan[1] (Parco Agricolo Sud Milano - PASM) in which the research has been carried out.

* Anna Gaviglio is teaching fellow in the Department of Agricultural, Food and Environmental Economics and Policy of University of Milan. Eugenio Demartini is PhD student of the School in Technology Innovation for Food and Environmental Science at the University of Milan. Alberto Pirani is full professor in the Department of Agricultural, Food and Environmental Economics and Policy of University of Milan.

[1] Established in 1990, the PASM is a public institution under the Province of Milan with the objective of preserving the economic, environmental and social functions of the rural economy in the area of South Milan (see also Figure 1).

The study is based on the concept of sustainability of production. In general, an efficient economy can be considered sustainable if it fulfills the so-called *three "Es",* that is to say, it guarantees *a prosperous economy, a quality environment and social equity*. There are at least two reasons why such conditions can only be guaranteed by institutional intervention: i) the principle of trade-off between efficiency and equity where a highly profitable economy pays the social costs of a high environmental impact and a certain degree of pollution; ii) the lack of remuneration (positive or negative) for the externalities (positive or negative) produced by agricultural activities.

In a situation that is often worsened by a high degree of asymmetry in information between producers to consumers, the farmers' decisions, aimed at maximizing profit, will probably focus on efficiency, considering equity as an accessorial part of production. For this reason, incentivizing/de-incentivizing or compulsory/prohibitive policies are necessary to guide farmers' behavior towards increased equity.

The use of chemical in order to achieve elevated yields and quality standards probably represents the most common and controversial example of negative agricultural externality. In this sense, Wilson and Tisdell (2001) note how, even given a panorama of increasing costs over the long term on an environmental, health and/or economic scale, farmers will continue to use pesticides and herbicides as long as a positive net return is assured short term. Institutions should therefore discourage or ban their use; but, how can we simultaneously safeguard the ecosystem and the consumer, provide adequate revenues to the farmers and guarantee a certain level of supply of agricultural commodities - that is, in this case: what is the impact on the production sector, where it is necessary to ban the use of a specific chemical?

We try to give an answer to the second question through the application of a Positive Mathematical Programming model using the data collected from a sample of farms. In the next section of the paper, a brief bibliographical review of useful articles is presented in order to focalize the argument, from the point of view both of methodology and of economic application. In section 3, the specific case study and objectives of the research are introduced, the methodology of which is presented in section 4. The main results of the document are outlined in section 5, while the last section of the paper proposes some considerations for future policy planning.

2. Background

Over the last decades, the concept of policy-making assisted by economic impact assessment has increasingly gained ground. In the European Union these have been the years of CAP reform and new definition of agri-environmental and food safety policy frameworks, so that agricultural economic research has greatly benefited from the necessity of analysing results of policy-making by means of *ex-ante* forecast models and *ex-post* evaluations.

Among the methodologies most frequently applied,, mathematical programming (MP) models have gained great popularity since Howitt (1995) proposed a positive interpretation to the maximization problem. Positive Mathematical Programming (PMP), indeed, provides a more credible simulation and eliminates the stop-start answers of the models from the Sixties and Seventies (Heckelei and Britz, 2000) by simulating the realistic options that are available to the farmers, while maintaining the flexibility of the mathematical models, potentially capable of representing any link between agricultural production variables in play, whether economic, biophysical or technical.

Buysse *et al.*. (2007) note that the very establishment of the problem of optimum production proposed by MP has guaranteed its success as a tool for describing the effect of the different agri-environmental policy on a particular farm. In fact, it allows the researcher to introduce variations in price (owing to taxes, subsidies or price support policies), in the use of input (e.g. Nitrates Directive) or in level of output (e.g. milk quota), or to forecast the results of strategies that impose determined standards (e.g. command-and-control policy). In particular, Schader *et al.*. (2008) raise the example of the success of the PMP models and profile a total picture of the main applications proposed over the last decade. Without going into specific detail on the different models (see Schader *et al.*., 2008 and its references), PMP methodology has been applied mostly on a national scale, showing variations on a regional scale. In this light, the current study presents a different approach, proposing the use of the PMP in a specific production sector in a well-defined area.

3. Objectives

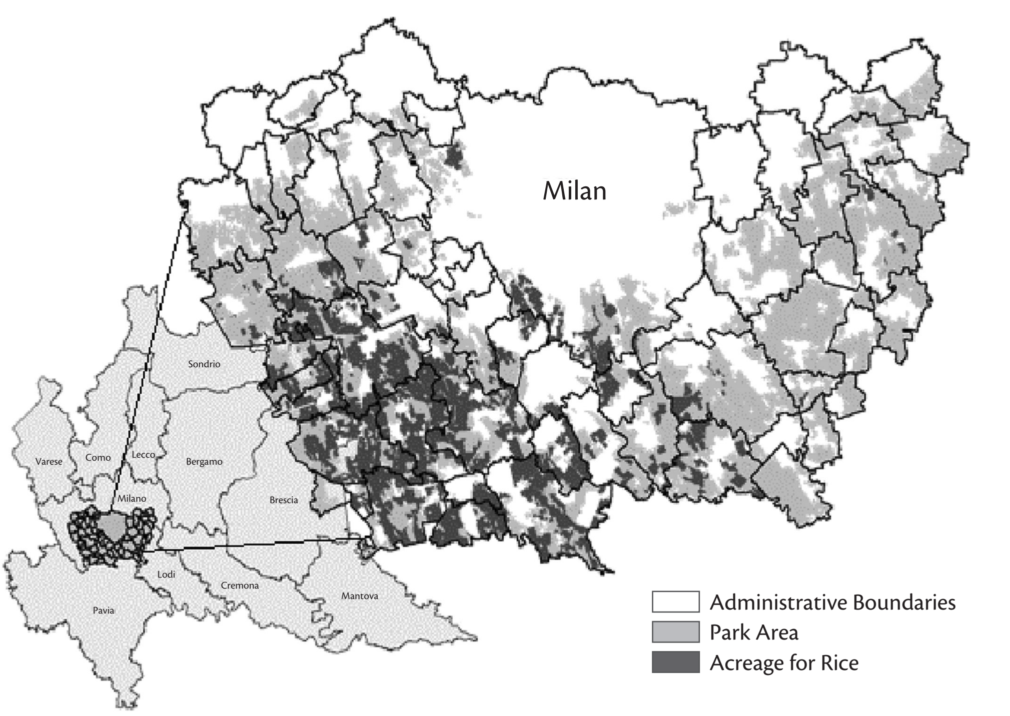
According to ISTAT, in 2008 about 1.4 million tons of rice were produced in Italy, which accounts for less than 0.3% of entire world production. It would seem to be a sector of marginal economic importance, whereas on the contrary it represents about 43% of all the rice produced in the European Community and considering that 93.5% of national production approximately comes from 6 provinces of Lombardy and Piedmont, it is obvious that the concentration of production makes rice an important economic resource in certain rural areas. As far as the province of Milan is concerned, more than two thirds of the surface area occupied by rice crops can be found in the PASM (*Table 1* and *Figure 1*). The area, which covers one third of the province and is characterized by the presence of 576 farms, represents an emblematic picture of the possibility (and necessity) for contact between densely populated metropolitan areas, like Milan, and agricultural land that lies around the outskirts.

Tab. 1 - Rice farms in the Parco Agricolo Sud Milano compared to the rice crops cultivated in Lombardy and Italy (year of reference 2008)

Rice production		PASM	Province of Milan	Lombardy	Italy
Harvested area	Ha	8,500	12,233	93,382	224,196
Production	t	51,000	64,965	589,699	1,388,927
Farms	num	107	216	1,973	4,501
Yields	**t/Ha**	**6.0**	**5.3**	**6.3**	**6.2**
Average farm size	**Ha**	**79.4**	**56.6**	**47.3**	**49.8**

Data: Istat, Italian Rice Institute and the Province of Milan.

Fig. 1 - Rice area in the PASM



The management of diverging objectives such as the protection of agricultural activity and the necessity for the growth of towns poses a number of problems for policy makers. Given the concentration of the rice-farming sector in this area, a simulation was carried out on the possible effects of the abolition of the use of tricyclazole against rice blast. The former is the only efficient product to combat the disease once it has begun to spread (Ghazanfar *et al.*, 2009; Moletti *et al.*, 1998). A ban on the product could lead to many situations; i) due to the lack of any restraint on the pathogen through the use of tricyclazole, and depending on climatic conditions and agronomic choices, it is estimated that up to 10-30% of the yield could be lost (Giudici *et al.*., 2008); ii) secondly, the lowering of chemical input, lowers, in turn, costs of production. The objective of the study is to estimate the combined effect of these changes on the farms in the sector, and forecast the trend in revenues and change in crop patterns.

4. Data and methodology

4.1. The model

PMP has been widely adopted in simulations of alternative policy and market scenarios through the use of technical and micro-economic data relative to the farms of a certain region or specific sector. The methodology has three phases:

1) For *n* sample farms, the first phase consists of setting up *n* linear programming models that resolve the function:

$$\max GM = \mathbf{p}_n\mathbf{x}_n - \mathbf{c}_n\mathbf{x}_n;$$

where *GM* is the gross margin of the farm, $\mathbf{x}_n$ is the vector of the quantity produced, to which the price vector $\mathbf{p}_n$ and the specific variable unit cost vector $\mathbf{c}_n$ are associated. The objective function is tied to a structural constraint $\mathbf{A}_n\mathbf{x}_n \leq \mathbf{b}_n$, and a calibration constraint, $\mathbf{x}_{nj} \leq \mathbf{x}_{Rnj}$, for $\mathbf{x}_{Rnj} > \mathbf{0}$ that allows the imputation of data referring to one year as a basis for future scenarios.

2) Assuming that the price of the input is fixed, in the second phase a function for the global cost of all the farms in the sample panel is formulated. It is assumed to be squared with respect to the produced quantities: $\mathbf{Qx}_R = (\boldsymbol{\lambda}_n + \mathbf{c}_n)$, where $\boldsymbol{\lambda}_n$ is the vector of differential marginal costs estimated in the first phase, Qx_R the symmetrical matrix, positive and semi-defined, and as such follows the following form:

$$\mathbf{C}(\mathbf{x}_R) = \int_0^{Xr} (\boldsymbol{\lambda}_n + \mathbf{c}_n)' \, d\mathbf{x} = \mathbf{x}'_R\mathbf{Qx}_R/2;$$

with a function of associated marginal costs, of the type:

$$cm(\mathbf{x}) \equiv \boldsymbol{\lambda} + \mathbf{c} = \mathbf{Qx}_R$$

What distinguishes the *n-th* farm from the remainder of the sample panel is a certain deviation ε_n from the function of border costs. It is supposed that every farm presents a shift from the function of optimum cost owing to farmer choices, so that the function of marginal costs for the macro-farm becomes:

$$cm(\mathbf{x}) \equiv \boldsymbol{\lambda} + \mathbf{c} = \mathbf{Qx}_{Rn} + \boldsymbol{\varepsilon}_n,$$

Such an approach allows us to consider the process of auto-selection made by farmers, that is, the relationship between their choices and the spectrum of choice presented relative to the variation in the type of crops present on the territory in question.

3) In the third phase of the model, the function of estimated marginal cost is applied to *n* non-linear programming models that reproduce the primary and secondary function of the linear programming model in the first phase.

For every farm, it is necessary to draft a quadratic programming model that is:

$$\max GM = \mathbf{p}'\mathbf{x}_n - (\mathbf{x}'_n\mathbf{Qx}_n/2 - \boldsymbol{\varepsilon}_n\,\mathbf{x}_n);$$

The solution obtained from the model reproduces the destination of use and the real production levels of the *n-th* farm for each farm in the panel sample and for the period of reference. Compared to the base model, some limitations have been included relative to subsidies received by farmers under the Mid-Term Reform of the European Community. The current regime of payment for the rice-farming sector has been taken into consideration, which foresees, up to 2013, decoupled aid to whoever has grown rice in the three years of reference, equivalent to 616.08 euro/ha, to which a coupled aid of 453 euro/ha is added, for whoever continues to cultivate rice.

The objective function is as follows:

$$\max ML = \mathbf{p}'\mathbf{x}_n + \mathbf{s}'\mathbf{hx}_n + \mathbf{eland}^*\mathbf{vent} - (\mathbf{x}'_n\mathbf{Qx}_n/2 - \boldsymbol{\varepsilon}_n\,\mathbf{x}_n);$$

subject to:

$$\mathbf{A}_n\mathbf{x}_n \leq \mathbf{b}_n \text{ con } \mathbf{x}_n \geq \mathbf{0};$$
$$\mathbf{A}_j\mathbf{x}_j - \mathbf{hx}_j = \mathbf{0} \quad \text{“}\boldsymbol{j} = \mathbf{1,\ldots,}\boldsymbol{J};$$
$$\boldsymbol{eland} \leq \boldsymbol{nent};$$

where **vent** = tpay/nent; being tpay = total payment and nent = number of titles; and ***eland* + *elands*** $\leq$ $\boldsymbol{hx}_j$.

The constraint ***eland*** $\leq$ ***nent*** indicates that the decoupled grant cannot be more than the maximum grant, while the constraint ***eland* + *elands*** $\leq$ $\boldsymbol{hx}_j$ specifies that the sum of land

admissible and non-admissible for the decoupled grant cannot be more than the total surface area employed by the farm. With this structure, the objective function means a payment that is partly coupled and partly decoupled for rice crops and totally decoupled for other crops.
To simulate the change in production yield for the rice, technical coefficients were used, represented by $\mathbf{A}_n$. In particular, with $\mathbf{s}_{Rnj}$, defined as the vector that represents the use of the land factor of the *n-th* farm, the matrix for the technical coefficients is defined as $\mathbf{A}_n = [\mathbf{a}_{nij}]$, where $\mathbf{a}_{nij} = \mathbf{s}_{Rnj} / \mathbf{x}_{Rnj}$. To simulate the variation in costs of rice production, given by the absence of the purchase and use of fungicide, a parameterization of the costs of production was effected equivalent to that usually applied to sale prices. To do this it is necessary to act on the linear component of production costs and not on the squared component, altering the vector $\boldsymbol{\varepsilon}_n$ of the deviation factors, that expresses the distance each company is from the border function. .

4.2. The Study area and the sample

Model data were collected through direct interviews and the Agriculture Databank of Lombardy Region. Out of the 576 farms effectively operating on the territory of the PASM, 514 were selected for the availability of information inherent to use of land, from which the representative panel of rice farms was selected through quota-sampling, using the following steps: i) classification of the farms in the PASM based on the Type of Farming (TF) and the European Size Units (ESU); ii) further sub-division of the population based on the territorial location of the farm with definition of four different production sectors; iii) calculation of the percentage weighting of the farming category (TF; ESU) in each territorial sector; iv) quantitative determination of the quota, aimed at obtaining a sample panel of rice farms that shows, for each class identified, a percentage weighting as similar as possible to the basic population (*Table 2* and *Table 3*).

Tab. 2 - Distribution of the farms in the PASM on the basis of TF and ESU

ESU - TF	Mixed	Cereal and rice	Cereal no rice	Livest. spec.	Livest. spec.	Total
1-8	17 *3.3%*	**0** ***0.0%***	27 *5.3%*	4 *0.8%*	18 *3.5%*	66 *12.8%*
8-16	9 *1.8%*	**1** ***0.2%***	33 *6.4%*	3 *0.6%*	4 *0.8%*	50 *9.7%*
16-40	15 *2.9%*	**23** ***4.5%***	39 *7.6%*	2 *0.4%*	7 *1.4%*	86 *16.7%*
40-100	9 *1.8%*	**41** ***8.0%***	42 *8.2%*	2 *0.4%*	13 *2.5%*	107 *20.8%*
>100	7 *1.4%*	**42** ***8.2%***	27 *5.3%*	33 *6.4%*	96 *18.7%*	205 *39.9%*
Total	57 *11.1%*	**107** ***20.8%***	168 *32.7%*	44 *8.6%*	138 *26.8%*	514 *100.0%*

Source: our calculations on sample data.

Tab. 3 - Distribution of the sample rice farms in the PASM										
Cereal and rice	**Class ESU**									
	8-16	**%**	**16-40**	**%**	**40-100**	**%**	**> 100**	**%**	**Total**	**%**
Sector 1 *Quota*			4 *1*	3.7% *7.7%*	2	1.9%	3	2.8%	9 *1*	8.4% *7.7%*
Sector 2 *Quota*	1 *1*	0.9% *7.7%*	18 *2*	16.8% *15.4%*	32 *3*	29.9% *23.1%*	35 *4*	32.7% *30.8%*	86 *10*	80.3% *76.2%*
Sector 3 *Quota*			1	0.9%	7	6.5% *7.7%*	3	2.8% *7.7%*	11	10.3% *15.4%*
Sector 4 *Quota*							1	0.9%	1	0.9%
Total *Quota*	1 *1*	0.9% *7.7%*	23 *3*	21.5% *23.1%*	41 *4*	38.3% *30.8%*	42 *5*	39.2% *38.5%*	107 *13*	100.00% *100.00%*

Source: our calculations on sample data.

4.3. Data sources and input variables for input to the model

Information from the Regional Agricultural Databank, regarding the use of land in the PASM territory, has allowed the identification of some farmers whose farms fit the technical and economic characteristics required for the sample panel and are also correctly positioned to be considered in the panel. The drafting of the tabulation model for the recording of data was carried out beforehand using Farm Accountancy Data Network (FADN) methods for the revenues and costs of agricultural firms in the European Economic Community.

For each farm, a series of data was gathered and recorded; the various items examined and their content enabled the calculation of the profit returned by production and its specific costs[2]. In terms of chemical products, the use of fungicide was closely examined and more especially, those products that are efficient combatants against the spread of *Pyricularia grisea*. Information on the quantity used, its distribution and the total costs were obtained so that an estimate of the costs per hectare and ton of product could be made. Lastly, a calculation of the percentage incidence for each active agent used for the control of rice blast was made, in order to collect all the input variables for the model (*Table 4*).

Tab. 4 - Standard model input variables and simulation input			
Input variables	**Year**	**Unit**	**Source**
Land use	2009	ha	SIARL/Farmers
Sold and re-used output	2009	t	Farmers
Variable costs for sold and re-used products	2009	€/t	Farmers
Prices of products sold	2009	€/t	Farmers
Subsidies and payments	2009	€/t	SIARL/Farmers
Average cost variation of tricyclazole application	2009	%	Farmers
Average cost variation of azoxystrobin application	2009	%	Farmers
Rice yield variations	2008	%	Giudici et al..

Source: personal analysis.

[2] Among the items for costs relative to the activity of the business, only variable costs have been considered, in particular: seeds, fertilizers, chemical products, third party activity, crop insurance and fuel and oil consumption.

The substance which is banned through the introduction of the law Reg. (EC) 1095/2007 is the active agent tricyclazole, which is used to fight the delayed outbreak of *Pyricularia grisea*, a primary cause of rice blast. Another active agent, azoxystrobin, is efficient in the prevention phase, but in cases where the fungal disease attacks the stem and cob of the rice plant, tricyclazole is the only efficient remedy against its spreading.

Another alternative is to employ agricultural techniques such as: the management of composts and fertilizers, most especially K-N; the use of strains that are more resistant and seeds that are healthy and robust; early sewing of seeds and a low level density of seeding. These technical measures can prove fundamental for avoiding the spread of rice blast, which can lead to lower than average yields and losses of up to 30% (Giudici *et al.*., 2008).

5. Results

From the data collected during our survey, it can be seen that 85% of rice farmers use tricyclazole to combat delayed outbreaks of the disease, and of these, 41% use azoxystrobin as well. Of the remaining 15% of rice farmers, 8% use absolutely no active agent, while 7% utilize only azoxystrobin.

The introduction of the legislation was simulated, by modifying the production yields and costs of production based on the choices made by farmers. We supposed they could adopt different strategies: simply eliminate the use of fungicides; replace tricyclazole with azoxystrobin; modify their agricultural techniques; or combine all three. Since it is impossible to simulate agronomic changes, simulations are based only on the variations of costs and hypothetical yields, should they cease to use tricyclazole and use azoxystrobin instead. From interviews with the persons concerned, it can be seen that 28% of farmers who use only tricyclazole would not use anything else; in this case, it is possible to forecast the reduction in production costs for each ton of rice, given the absence of purchase of fungicide. It was estimated that for those farmers who would replace tricyclazole with other active agents, the costs in production do not change significantly. For those who used both tricyclazole and azoxystrobin at the same time, on the same cultivated land, the total reduction in production costs was made based on an absence of purchases of tricyclazole.

Two possible hypotheses were considered regarding production costs, as shown in *table 5*. The first demonstrates, in the case of the 85% of rice farmers who used tricyclazole in the past, a reduction of 4.71% on the costs of production, while the costs pertaining to the remaining 15% of rice farmers have remained unchanged. The average percentage incidence of the cost of using tricyclazole on the total production cost of rice is 4.71%. In the second hypothesis, once again taking the figure of 85% of rice farmers as the point of reference, production costs are cut by 2.27%; this figure is the average percentage value of cost reduction compared to the total production cost if tricyclazole is replaced by azoxystrobin.

Tab. 5 - Scheme of scenarios examined		
Scenarios	**Cost hypothesis**	**Reduction of rice yield**
SIM_01	4,71% decrease	10%
SIM_02	4,71% decrease	15%
SIM_03	4,71% decrease	20%
SIM_04	4,71% decrease	25%
SIM_05	4,71% decrease	30%
SIM_06	2,27% decrease	10%
SIM_07	2,27% decrease	15%
SIM_08	2,27% decrease	20%
SIM_09	2,27% decrease	25%
SIM_10	2,27% decrease	30%

Source: personal analysis.

For each of the two hypotheses, variation in yield with losses from 10 to 30% were simulated, and simulations performed 10 times in total. In *table 6*, the results of the simulations are listed, showing the estimated trends in farm's average production and gross revenues. If tricyclazole is not replaced and the reduction of the yield is slight, that is, equivalent to 10% (SIM_01), the gross revenues of the farmer are increased. It is plausible to assume that if an alternative product is not used in place of tricyclazole, the yield is reduced to a greater degree, but in (SIM_01) it is interesting to note that the cost incidence of tricyclazole is approximately equal to 10% of total production. In the case of higher production losses, (SIM_04 and SIM_05), the gross revenues can decrease by 4-5%. This is perhaps the most realistic simulation, in the short term, for those farmers who do not intend to replace tricyclazole and for whom a better understanding of the changes that arise from not using the active agent follows a learning curve that they will undertake over the course of the several years.

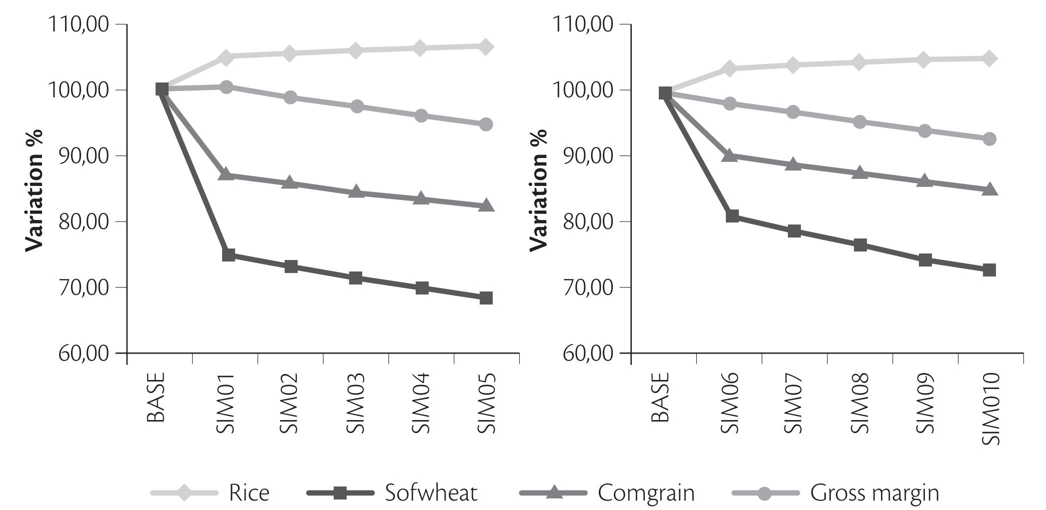
For those farmers who are keen to replace tricyclazole, on the other hand, it is more realistic to consider only a slight reduction in yield; in SIM_06 and SIM_07, the gross revenues decrease by 2-3%. However, where certain atmospheric conditions prevail and in the case of a delayed outbreak of rice blast, the ban on the use of tricyclazole could cause much higher yield losses, even around 30%, which would in turn cause a reduction in revenues of up to 7% (SIM_10).

Tab. 6 - Crop production and gross margin												
CROPS	**UM**	**BASE**	**SIM_01**	**SIM_02**	**SIM_03**	**SIM_04**	**SIM_05**	**SIM_06**	**SIM_07**	**SIM_08**	**SIM_09**	**SIM_10**
Corn	ton	848.3	729.4	719.1	709.5	700.6	692.3	762.3	751.1	740.7	731.0	721.9
	% var.	*100.0*	*85.2*	*84.0*	*82.9*	*81.8*	*80.9*	*89.1*	*87.7*	*86.5*	*85.4*	*84.3*
Soft wheat	ton	382.2	293.6	289.5	285.9	282.6	279.5	320.1	313.8	308.0	302.7	298.5
	% var.	*100.0*	*76.9*	*75.9*	*74.9*	*74.1*	*73.2*	*83.9*	*82.2*	*80.7*	*79.3*	*78.2*
Rice	ton	4,437.7	4,230.4	4,060.2	3,902.9	3,757.5	3,622.6	4,180.5	4,016.0	3,864.0	3,723.1	3,591.1
	% var.	*100.0*	*95.4*	*91.6*	*88.0*	*84.8*	*81.7*	*94.3*	*90.6*	*87.2*	*84.0*	*81.0*
Gross margin	**% var.**	**100.0**	**100.3**	**98.7**	**97.3**	**95.9**	**94.6**	**98.5**	**97.0**	**95.6**	**94.3**	**93.1**

Source: our calculations on sample data.

What arises in general from the results is that, given a reduction in yield of the rice crop, which is their main source of income, farmers are persuaded to do away with the marginal crops, like wheat and corn, and to plant more rice, as described in *Fig. 2*. In other words, to maintain an adequate gross margin, the phenomenon of single crop cultivation is pursued by cutting out the hectares given over to wheat and corn. An increase in the single crop cultivation of rice, however, is in direct contrast with the aim of improving and implementing best practice techniques of crop growing, so useful in the fight against the spread of disease. Whereas one technique against the fungus is to reduce the density of sowing, intensification is a mechanism that is founded on principles that are diametrically different, as rotation is a technique used to prevent the spread of diseases. From this point of view, the simulations would seem to present the new regulation as counter-productive, to be borne in mind, with a view to monitoring the changes in the Italian rice-growing sector over the mid- to long-term.

Fig. 2 - Land use and gross margin



Source: personal analysis.

6. Final remarks

The concept of sustainability nowadays is the guideline in agro-environmental policy-making. This means trying to guarantee both economic prosperity and a safe environment for everyone, not an easy objective to reach, given market constraints. Agricultural policy is a long-standing example of this difficulty: any incentives arising from low intensity production models, that have a low environmental impact, is in contrast with the need to ensure a certain level of supply on the commodity market, to sustain a threshold of revenue for the farmer and consequently, the survival of the farming business and its involvement in the preservation of the land.

The radical reforms of the CAP made over the last few years have provided a boost for the field of research into forecasting analysis for situations linked to specific policy choices. Most notably, the method of the PMP has gained ground, for many different reasons, and nowadays is in widespread use for regional and sectoral analysis. In this paper we looked at a PMP model that illustrates some of the results following from a ban on the use of tricyclazole in the rice-farming sector in a well-defined production zone. The simulations conducted highlight two effects: i) reduction of the farm's gross margin e ii) an increasing tendency towards single crop cultivation of rice. The ban is necessary, however, for environmental reasons and for consumer protection, and its costs, perceived as a loss in revenues for the farmer, could be a viable option for policy-makers, but the increase of single crop cultivation also presents a high risk in the long term for agricultural land and the surrounding environment, and although these costs cannot be estimated, they could be more significant.

The analysis focuses on a positive policy-making approach that outlines a reaction on the part of farmers that could even be counter-productive for the overall sustainability of the regulatory intervention. The present application shows the side effects of a specific introduction of the ban, underlining the effects on losses in gross margin and the possible strategies of farmers to contrast them. This demonstrates, should it still be necessary to do so, that economic research applied to agriculture is of great assistance to decision makers. In this case, for example, the policymaker should consider the possibility of setting up a technical-agronomical database capable of identifying feasible substitutes to tricyclazole in combating rice blast in order to compensate the decrease in farmers' gross margin.

REFERENCES

Agarwal, P. C., Mortensen, C. N., and Mathur, S. B. (1989), "Seed-borne Disease and Seed Health Testing of Rice", *Phytopathological papers no. 30*, Technical bulletin CAB International Mycological Institute, UK.

Buysse J., Van Huylenbroeck G., and Lauwers L. (2007), "Normative, positive and econometric mathematical programming as tools for incorporation of multifunctionality in agricultural policy modelling", *Agriculture, Ecosystems & Environment*, 120 (1), 70–81.

Ghazanfar, M.U., Wakil, W., Sahi, S.T., and Yasin, S.I. (2009), "Influence of various fungicides on the management of rice blast disease", *Mycopath*, 7 (1), 29-34.

Giudici M. L., Picco A. M., and Rodolfi M., (2008), *Malattie*, In A. Ferrero (eds), Il Riso, Bayer CropScience, Ed.Script, Bologna, 366-368.

Heckelei, T., Britz, W., (2000), "Positive Mathematical Programming with Multiple Data Points: A Cross-Sectional Estimation Procedure", *Cahiers d'Economie et Sociologie rurales*, 57, 28-50.

Howitt, R. E. (1995), "Positive mathematical programming", *American Journal of Agricultural Economics*, 77 (2), 329-342.

Kuyek, D. (2000), Blast, Biotech and Big Business. http://www.grain.org/briefings/?id=138, on 15 May 2010.

Moletti M., Giudici M. L., Nipoti, E. and Villa, B. (1988), "Chemical control trials against rice blast", *Informatore Fitopatologico*, 80, 41-47.

Rao, K. M. (1994). *Rice Blast Disease*, Daya Publishing House, Delhi, India.

Schader, C., Sanders, J., Offermann, F., Lampkin, N. and Stolze, M. (2008), "Cost-effectiveness evaluation of Swiss agri-environmental measures on sector level", Paper presented at the 107th EAAE seminar, Sevilla, Spain, January 29th -February 1st, 2008.

Wilson, C., and Tisdell, C. (2001), "Why farmers continue to use pesticides despite environmental, health and sustainability costs", *Ecological Economics*, 39, 449-462.