## Séminaire de recherche

# Micro-économie et micro-économétrie de la production agricole

**16 et 17 Novembre 2009**
**Rennes - France**

Organisé par l'UMR-Smart
INRA, Département SAE2

# Abolition of the EU milk quotas and dairy farmers' productive strategies

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**Abstract -** A bio-economic model is developed to measure the productive, economical and environmental impacts on French dairy farms of the milk quota abolition. While respecting the principle of agent rationality (maximization of profit), the model incorporates the economic risk related to the volatility of input and output prices. Thus, the model maximises the expected utility of income while taking into account a set of constraints: regulatory, structural, zootechnical, agronomic and environmental. Simulations show that French dairy farms have a strong production potential but this increase in milk volume results in an intensification of the production system and has negative effects on the environment.

**Keywords**: Dairy farm; milk quota abolition; CAP Health Check; bio-economic model

**Résumé** - Un modèle bio-économique est élaboré afin de mesurer les impacts productifs, économiques et environnementaux sur les exploitations laitières françaises de la suppression du régime des quotas laitiers. Tout en respectant le principe de rationalité de l'agent (maximisation du profit), le modèle incorpore le risque économique lié à la volatilité des prix des productions agricoles. Le modèle maximise ainsi l'utilité espérée du revenu tout en tenant compte d'un ensemble de contraintes: réglementaires, structurelles, zootechniques, agronomiques et environnementales. Les simulations montrent que les exploitations laitières françaises possèdent un fort potentiel de production mais cette augmentation du volume de lait produit est permise par une intensification du système productif et entraîne des effets négatifs sur l'environnement.

## 1. Introduction

For EU dairy farmers the Luxemburg agreement, decided in 2003, marked a new phase in the process of Common Agriculture Policy (CAP) reform. The direct payments were decoupled and the Single Payment Scheme (SPS) was implemented. This reform aimed to increase the competitiveness of European agriculture and to promote a market orientated agricultural sector. The new CAP reform proposed in 2008 (known as the CAP Health Check) maintains these objectives of decoupling and the removal of the milk quota system in 2015. In France, more than in some others EU member states, this decision raises questions because the government historically favoured a balanced geographical distribution of milk production through an administration of milk quotas. Moreover, for dairy farmers, these changes occurred simultaneously with an unprecedented market situation, namely high price fluctuations of agricultural raw materials.

In this context, the aim of this article is to study the implications of the abolition of milk quotas on dairy farmers' behaviour (i.e. effects on the production system, the allocation of areas to crops, and the level of intensification) with different hypothetical prices. A bio-economic model is developed and applied to four case studies: french dairy farms often have, in addition to the dairy activity, cereal or beef production. The model will allow us to highlight changes in the productive strategies of farmers in particular by studying the balance between the different productions (milk, cereals, meat) and the environmental impact at farm level (evolution of nitrogen pressure, use of purchased feed, intensification of milk production and fertilizer use).

## 2. Dairy policy setting

In France, as in all member states of the EU, milk production has been regulated since 1984 at the producer level (any excess over the authorized quantity causes a financial penalty). Milk quotas were introduced in order to control the supply of milk in a context where the storage costs of the dairy surplus became an important issue for the EU budget. Moreover, in a context marked by a modest growth in domestic consumption of dairy products and a strong competition with the countries of Oceania (Australia and New Zealand) on export markets, the authorities have been forced to progressively reduce quotas in most member states. Thus, France has lost 12% of its milk production in twenty-five years and nearly half of his herd of dairy cows (due to the steady rise in the milk yield). In France, state intervention in the management of milk quotas is stronger than in most other Member States, particularly the United Kingdom, Denmark and the Netherlands where milk quotas are tradable. Indeed French authorities have adopted rules to limit the geographic concentration of milk production in regions/departments with comparative advantages: milk quotas are managed administratively in each department and they are linked to the land. A producer who wishes to increase milk production must necessarily acquire or rent hectares. The transactions of quota between producers are made by administrative decision (free attribution of volume to priority producers) and not through the market.

This regulation method for the milk supply (quota) within the EU and France is also applied in other countries such as Canada (where quotas are tradable between producers) and New Zealand (where the volumes are managed by the monopolistic cooperative enterprise, Fonterra, which provides the collection, processing and export of milk). In the United States, unlike the EU and France, milk production strongly increased over the past fifteen years (1.5 million tons of milk per year). This increase in supply, in a non limited system, allows them mainly to meet domestic demand, because exports on the world market are still relatively limited (10 % of the world market volume in 2008).

Twenty-five years after the implementation of milk quotas, the European Commission (2008) estimates that: “The current market outlook situation indicates that the conditions for which milk quotas were introduced in 1984 are no longer relevant.” It proposes a phasing-out of milk quotas with a gradual annual increase to prepare farmers for a market without quotas post 2015. This decision also reflects some theoretical arguments against this way of regulation. Many studies (see e.g. Alvarez et al., 2006; Boots et al., 1997) show that the milk quota system is a source of inefficiencies with a non-optimal allocation of quota among producers because a high number of vulnerable and inefficient producers remain in milk production. Colman (2000) and Henessy et al. (2009) show that even if milk quotas are tradable, there are lags in adjustment and imperfections such that the theoretical optimum has not been achieved.

The removal of milk quotas by 2015 which seems to be accepted by the majority of EU Member States, raises many questions in France. These questions concern, on the one hand, the evolution in the geographical concentration of production at the national level and, on the other hand, the evolution in milk prices paid to producers. On this last point, it is clear that the milk quota system has allowed the French and European producers to benefit from stable and remunerative prices over the past two decades.

In the absence of a milk quota, the risk of a greater price volatility and lower prices exists (Bouamra-Mechemache et al., 2008), all the more so as the elasticity of demand is low in this sector. Several studies, based on partial and general equilibrium models, have already assessed the impact of the abolition of milk quotas on the price level in the EU (Kleinhanss et al., 2002; Lips and Rieder, 2005 and Gohin and Latruffe, 2006). They showed that such a policy would lead to an increase in European milk production by 10 % for a diminution in prices by 26 %.

## 3. Methodology

The previous studies of the abolition of the milk quota estimate the change in production and demand for dairy products at the regional or national level, but none of them analysed the impact at the farm level. This study builds a bio-economic model which takes into account the farmer’s response to price variation and several technical and biological elements in order to represent as accurately as possible the functioning of a dairy farm. Mathematical Programming is a technique which enables us to represent the farm functioning in reaction to a set of constraints. LP is a relevant technique because its hypotheses correspond to those of classic micro economics: rationality and the optimising nature of the agent (Hazell and Norton, 1986). This method allows us to study the threshold effects and to calculate dual values of inputs. Farm-level modelling enables simultaneous consideration of production, price and policy information.

### *3.1. Bio-economic model: optimisation of the income*

The model optimises the farm plan, which represents the quantities of different outputs produced and inputs used. The economic results follow from those quantities and their prices. The model is used to estimate the effects of institutional, technical and price changes on the farm plan, economic results and intensification indicators.

Many studies have demonstrated that farmers typically behave in a risk-averse way (Hardaker et al., 2004). As such, farmers often prefer farm plans that provide a satisfactory level of security even if this means sacrificing some income. For the farmer, the main issue raised by variability of price and production is how to respond tactically and dynamically to opportunities or threats to generate additional income or to avoid losses. Moreover, during the year 2007 and 2008, prices of agricultural commodities were subject to strong variations so we had to take the farmer's sensitivity to price volatility. For example, the price of milk paid to the producers nearly doubled through 2007, from 240 €/t to 380 €/t before strongly decrease until 220 €/t in April 2009. Prices of cereals such as wheat follow the same fluctuations. Cereals play a special role in dairy farming because they can be both input and output.

In this study we use the Utility efficient programming (UEP) with a negative exponential utility function. Lambert and McCarl (1985) presented a mathematical programming formulation that allows identification of the expected utility function. Their approach, which does not require an assumption of normally distributed income (on the contrary of the E-V, MOTAD models and Target MOTAD methods), can accommodate the assumption that the utility function is monotonically increasing and concave (risk-averse). Patten et al (1988) reformulated this approach as Utility efficient programming (UEP). Moreover, Zuhair et al. (1992) show that negative exponential utility function (with a constant absolute risk aversion CARA) can better predict farmers' behaviour compared with cubic and quadratic functions. The CARA function is a reasonable approximation to the real but unknown utility function: coefficient of absolute risk variation can be validly applied to consequences in terms losses and gains for variations in annual income. Thus model maximizes the expected utility of the income (1):

$$\text{Maximize:} \quad E[U] = p\, U(k, r), \quad r \text{ varied} \tag{1}$$

$$\text{With:} \quad U_k = 1 - \exp(-r_a \times Z_k) \tag{2}$$

where $Z$ is the net farm income for state $k$ and $r$ is a non-negative parameter representing the coefficient of absolute risk aversion:

$$r_a = (1 - \lambda)r_{min} + \lambda r_{max}, \qquad \text{for } 0 \leq \lambda \leq 1$$

where λ is a parameter reflecting variation in risk preference, and $r_{max}$ and $r_{min}$ are upper and lower bounds of the coefficient of absolute risk aversion ($r_a$).

In a more detailed form, the income $Z$ is defined by (3):

$$\begin{aligned} Z = &\sum_{a}\left(T_a \times mY_{t,a}\right) \times 305 \times mP + \sum_{a}\left(aS_a \times aW_a \times aP_a\right) \\ &-\sum_{a,p}\left(T_a \times \left(cfQ_{conc,p,a} \times cfP_{conc} \times 91.25 + I_a\right)\right) + \sum_{c}\left(X_c \times \left(Y_c \times cP_c - I_c - nQ_c \times nP\right)\right) + dP - FC \end{aligned} \tag{3}$$

The main part of the income $Z$ is given by milk revenues: the milk quantity produced with $T_a$ the total number of animal of type $a$ (dairy cows, heifers, calves and young bulls) ; $mY_{t,a}$ the milk yield (litter/day) per animal by $mP$ the milk price (€/litter). There is then the meat revenue with $aS_a$ the number of animal selling ; $aW_a$ the carcass animal weight (kg) and $aP_a$ the meat price (€/kg). Then we take out the animal costs with: $cfQ_{conc,p,a}$ the quantity of concentrate feed ingested (kg/animal/day) ; $cfP_{conc}$ is the concentrate feed price (€/kg) ; $I_a$ the specific inputs for animals (artificial insemination, medicines, herd book and minerals). We add the crop revenue with: $X_c$ the cultivated area (ha) for each type of crop $c$ (wheat, corn, rapeseed, pea, corn silage, pasture, hay and grass silage) ; $Y_c$ the crop yield (kg/ha) ; $cP_c$ the crop price (€/kg) ; $I_c$ are the specific crop inputs (seed, treatments and harvesting) ; $nQ_c$ the nitrogen quantity (kg/ha) ; nP the nitrogen price (€/kg). And finally we consider the direct payment $dP$ and the fixed costs $FC$ (mechanisation, buildings, rent for land and taxes).

Thornton and Herrero (2001) show that a wide variety of separate crop and livestock models exist, but the nature of crop–livestock interactions, and their importance in farming systems, makes their integration difficult. That is why, in order to precisely describe the operation of a dairy farm this model considers four important characteristics: i) the seasonality of labour and grass production, ii) the response of crop yield to nitrogen use, iii) the non linearity of milk yield per cow and iv) the interaction between crop and animal production.

i) Four periods $p$ (spring, summer, autumn and winter) are distinguished in the model. It allows for seasonal specification of grass production and grassland use (Berentsen et al., 2000). Seasonal variations enable us to integrate differences in the growth potential of grass during the growing season as well as the evolution of the nutrient content of grass. Moreover, in equation 4, we introduce seasonal labour constraints by allocating labour needs to each activity according to the work peaks (harvesting and calving time). It is assumed that the farmer and his family/associates execute all the work and thus there is no option to hire temporary labour. The model is more able to reflect temporal conditions thanks to the addition of these parameters.

For each $p$: $$\sum_a \left(\left(Wt_{a,p} \times T_a\right) + \left(Wt_{c,p} \times X_c\right)\right) + FL \quad \leq \quad AL_p \times AWU \qquad (4)$$

The global working time per period (with $Wt_{a,p}$ the working time per animal ; $Wt_{c,p}$ the working time per ha of crop ; $FL$ is the fixed labour) has to be lower than the labour availability per period ($AL$ the available labour for each annual work unit ($AWU$)).

ii) Crop yield depends on the quantities of nitrogen used. Godard et al (2008) formulated an exponential function which satisfies economic requirements for attaining a mathematical optimum (the yield curve has to be concave and strictly increasing) and is consistent with its expected agronomic shape and with parameters with an agronomic interpretation.

$$Y_c = Ymax_c - (Ymax_c - Ymin_c) \times e^{-\sum t_i N_i} \qquad (5)$$

where $Y_c$ is yield for each crop, $Ymin_c$ and $Ymax_c$ respectively the minimal and maximal yield (different according to the type of farming and its level of intensification); $t_i$ represents the rate of increase of the yield response function to a nitrogen source $i$ (e.g. manure, slurry, chemical nitrogen, etc.) the quantity of which is $N_i$. This enables us to take the increasing price of nitrogen into account and the flow of organic nitrogen on the farm (Manos et al., 2007).

iii) The milk production per cow is not fixed in order to give more flexibility to the model, that is why we consider two types $t$ of milk. Farmers have the possibility to choose the milk yield per animal in a range of 1,000 liters below the dairy cow genetic potential. It is also possible for farmers to produce beyond the genetic potential: in this case nutritional requirements needed to produce one liter of milk are increased (change from 0.44 energy unit per liter of milk to 1.2 unit, and from 48 to 140 units of protein per liter of milk).

iv) With these three above mentioned elements, we can very accurately represent the feeding system. The quantity ingested per cow per day is determined by using i) nutritional requirements in biological unit $b$ (energy and protein) and ii) the composition of forages and concentrate feed (INRA, 2007) in equation 6. The concentrate feeds *conc* available in the model are soybean meal, rapeseed meal, wheat, production concentrate and milk powder.

For $b$ and $p$

$$\sum_{a}\left(T_a\left(MR_{a,b}\times 365+mY_{t,a}\times LR_{t,a,b}\times 305\right)\right) \leq \sum_{a,c}\left(T_a\times\left(fQ_{c,p,a}\times fnc_{c,p,b}\times 91.25\right)\right)+\sum_{a,conc}\left(T_a\times\left(cfQ_{conc,p,a}\times cfnc_{conc,p,b}\times 91.25\right)\right) \quad (6)$$

With: $MR_{a,b}$ the maintenance requirement
$LR_{t,a,b}$ the lactation requirement
$fQ_{c,p,a}$ the forage consumption for each crop $c$, each period $p$ and each type of animal $a$
$fnc_{c,p,b}$ the forage nutrient content
$cfQcon_{c,p,a}$ the concentrate feed consumption
$cfnc_{conc,p,b}$ the concentrate feed nutrient content

The global nutritional needs for the herd must not exceed the availability in forage and concentrate feed. The lactation period is 305 days with then a drying up period of 60 days before calving.

subject to: For each $c$ $\sum_{a,p}\left(T_a\times\left(fQ_{c,p,a}\times 91.25\right)\right)\leq X_c\times Y_c$ (7)

The forage consumption (for each type of forage $c$) has to be lower than the forage production

Consequently, the model determines the optimum number of each type of animals ($T_a$ and $aS_a$), the milk yield per cow ($mY_{t,a}$), the concentrate feed and forage consumption ($cfQ_{conc,p,a}$, $fQ_{c,p,a}$) the crop rotation ($X_c$) and the level of nitrogen fertilisation ($nQ_c$) in order to maximize the farm's income.

*3.2. The constraints*

Regarding the farm structure the model incorporates the agricultural area, the milk quota and the available labour resources. For the building constraint, we consider that the number of cows can increase by 10% in comparison to the base year: the implementation of the Global Monitoring for Environment and Security program has motivated many dairy farmers to construct new buildings with more places than required. Regarding crops, the model meets the requirements for the rotation frequency and cropping pattern.

We also include three environmental measures as constraints in the model: i) the European Council directive concerning the protection of waters against pollution caused by nitrates from agricultural sources requires that farmers cannot exceed organic nitrogen application rates of 170 kg nitrogen per hectare; ii) farmers have to keep grasslands aged over 5 years ; iii) in addition to the CAP premiums, a premium for the maintenance of extensive livestock systems or ‘‘premium for grassland’’ is attributed (75€/ha), provided there is at least 75% of grass in the total farm area and if the stocking rate is below 1.4 “livestock units” per hectare of grass.

*3.3. Calibration: one model for four types of farming*

In France, there is a high diversity of dairy farms in terms of location (mountains/plains), intensification level (intensive/extensive), feeding system (pasture/maize silage) and specialisation of production (specialized/diversified). In this context, our choice focused on the four main types which predominate in France (see Table 1). There are two specialized milk farms the G*razier* farm and the *Semi-intensive* farm and two diversified farm where dairy production is the main activity but they also have another production: cereals crops for the *Milk+cereals* farm and a fattening activity for the *Milk+young bulls* farm.

**Table 1.** Specific farm data.

| | Grazier Farm | Semi-intensive Farm | Milk+cereals Farm | Milk+young bulls Farm |
|---|---|---|---|---|
| Share of the system in France (%) | 8 % | 22 % | 30 % | 18 % |
| Total area (ha) | 78 | 50 | 137 | 100 |
| Milk quota (liters) | 285 000 | 290 000 | 460 000 | 400 000 |
| Annual Work Unit (nb) | 1.7 | 1.5 | 2.0 | 2.7 |
| Building capacity (nb) | 62 | 37 | 59 | 122 |
| Restocking rate (%) | 0.25 | 0.35 | 0.37 | 0.4 |
| Dairy genetic potential (l/year) | 6 000 | 8 500 | 8 500 | 9 000 |
| Max crop yield (kg/ha/year) | | | | |
| Wheat | 6 100 | 8 100 | 8 100 | 8 100 |
| Maize | n.a.[1] | n.a. | 10 000 | n.a. |
| Rapeseed | n.a. | n.a. | 3 800 | n.a. |
| Pea | n.a. | n.a. | 5 000 | n.a. |
| Maize silage | 10 200 | 12 200 | 15 200 | 14 200 |
| Grass Silage | 8 500 | 8 500 | 8 500 | 8 500 |
| Grass | 8 500 | 7 000 | 6 000 | 6 000 |
| Hay | 8 500 | 7 500 | 7 500 | 7 500 |
| Milk price (€/l) | 300 | 280 | 280 | 280 |
| Meat price (€/kg) | 3.2 | 3.0 | 3.0 | 3.0 |
| Dairy cow carcass weight (kg) | 375 | 325 | 325 | 325 |

[1] n.a.: not available

The calibration step is necessary: the model's results and the empirical observations have to be close. We use the PMP method (Positive Mathematical Programming) (Howitt, 1995) to calibrate the model for each type of farm. The economic and technical data come from the annual survey of the Institut de l'Elevage (2008) which consists of more than 640 dairy producers. As a result of this procedure, we estimate λ (risk aversion coefficient) at a level of 0.5.

## 4. Results and discussion

The results of the simulations are compared to a baseline 2008 which takes into account the full implementation of the CAP Health Check measures (full decoupling of animal and crop premium and removal of set-aside). In the simulation, we assume that milk producers have the opportunity to increase their milk production up to 25% compared to the baseline. This rate was fixed arbitrarily by considering that the removal of quotas would result in an increase in contracts between milk producers and processing companies. Indeed, companies or cooperatives could be encouraged to replace public regulation through certain contractual policies. The producers will be limited in their productive potential by the rules established within the framework of a contract, itself dependent on the historical milk quota. This hypothesis (+25%) is retained by considering, first, that the milk quota will be increased by 5 % between 2009 and 2015 (following the decisions of November 2008) and, secondly, that the restructuring process will lead to a decrease in the number of dairy farms by 20 % over the period. In other words, the authorized volume growth is permitted with a simultaneous decrease in the number of farms.

Without the use of milk quotas, the future milk price is not predetermined. If these contractual policies permit a rigorous management of the collective supply, the producer milk price reduction could be less severe than calculated by theoretical models. Therefore the price of milk in the model (280€/t) is identical between the base year and the simulation, but we also test the sensitivity of dairy producers to milk and cereal price variations.

### *4.1. Base year results*

Regarding the two case studies of operations specialized in milk production (*Grazier* and S*emi-intensive*), they have a very similar economic dimension (500 € difference of income) while the structure of these two farms and their strategy are very different (see Table 2).

The *Grazier* farm opts for an extensive system of production: the whole area of the farm is dedicated to grassland, thus enabling it to meet the criteria of the “Grass Premium” and benefit from 5 900 €/year. With an annual milk yield of 5 250 liters per animal, the farmer chooses to remain 750 liters below the genetic potential of dairy cows. This decision has the effect of requiring a greater number of animals in order to produce the same quota. In doing so, the farmer has a greater meat revenue (the prices of milk and meat are higher thanks to a better milk composition (fat and protein) and heavier carcasses (Normand cow)). This low level of production allows the farmer to apply a low cost strategy since dairy cows consume only 120 kg of purchased concentrate feed per year. Note that the variable costs for the *Grazier* farm are lower than the *Semi-intensive* farm, however the larger size of the G*razier* farm (area, building) generates a higher amount of fixed cost.

The *Semi-intensive* farm applies a more productive strategy even if it has only 50 ha of total area (28 ha less than the *Grazier* one) for an equivalent quota: it allocates nearly 25 % of this area for cereal production (with a 16 500 € profit per year). Furthermore, the farmer chooses to use maize silage to feed the animals and to use a high amount of concentrate feed (890 kg/VL/year) allowing to reach a milk yield of 8 500 liters per year. It reduces the number of animals required for the production of the milk quota and thus free-up land for cereals. The dual values of land and quota are positive for both farms showing an increase of these two inputs would result in a higher income, however, the Semi-intensive farm is more highly constrained by the land factor.

**Table 2.** Economic and productive impact of an abolition of milk quota

| | Grazier Farm | | Semi-intensive Farm | | Milk+cereals Farm | | Milk+Young bull Farm | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Quota +25 % | Baseline | Quota +25 % | Baseline | Quota +25 % | Baseline | Quota +25 % |
| Income (€) | 55 200 | 70 400 | 54 700 | 61 300 | 123 200 | 132 100 | 120 700 | 133 000 |
| | | | | Crop area | | | | |
| Cereals | 0.0 | 0.0 | 11.7 | 8.1 | 99.3 | 97.5 | 20.6 | 21.6 |
| Silage maize | 0.0 | 0.0 | 10.4 | 10.9 | 23.5 | 25.3 | 44.0 | 41.3 |
| Grassland | 78.0 | 78.0 | 27.9 | 30.9 | 14.2 | 14.2 | 35.4 | 37.1 |
| Premium for grassland | yes | yes | no | no | no | no | no | no |
| | | | | Animal activity | | | | |
| Total produced milk (l) | 299 200 | 357 800 | 298 700 | 345 500 | 461 400 | 552 800 | 445 970 | 504 400 |
| Total sold milk (l) | 285 000 | 356 250 | 290 000 | 344 400 | 460 000 | 551 295 | 400 000 | 500 000 |
| Dairy cows (nb.) | 57 | 58 | 35 | 38 | 54 | 59 | 50 | 55 |
| Young bull (nb.) | | | | | | | 77 | 60 |
| Milk yield (l/year) | 5 250 | 6 150 | 8 500 | 8 970 | 8 500 | 9 310 | 9 000 | 9 000 |
| Concentrate feed (kg/cow/year) | 120 | 420 | 890 | 1 250 | 1 200 | 2 630 | 1 010 | 1 000 |
| Milk l/ha forage area | 3 840 | 4 590 | 7 800 | 8 250 | 12 230 | 13 980 | 5 620 | 6 430 |
| Organic nitrogen pressure (kg/ha) | 132 | 135 | 115 | 126 | 64 | 70 | 146 | 142 |
| Chemical nitrogen used (kg/year) | 6 080 | 6 900 | 6 010 | 5 930 | 19 100 | 19 000 | 10 720 | 11 130 |
| Working time (h/awu/year) | 1 940 | 1 980 | 1 560 | 1 670 | 1 940 | 2 090 | 2 060 | 2 030 |
| | | | | Economic results | | | | |
| Total revenue (€) | 142 800 | 164 900 | 132 100 | 145 200 | 315 300 | 340 700 | 301 200 | 313 900 |
| Milk revenue (€) | 85 500 | 106 900 | 81 200 | 96 400 | 128 800 | 154 400 | 112 000 | 140 000 |
| Meat revenue (€) | 33 600 | 34 300 | 16 500 | 18 100 | 23 300 | 25 500 | 102 100 | 85 700 |
| Crop revenue (€) | 0 | 0 | 12 300 | 8 600 | 106 200 | 103 900 | 21 800 | 22 800 |
| Total subsidies (€) | 23 800 | 23 800 | 22 100 | 22 100 | 56 900 | 56 900 | 65 300 | 65 300 |
| Variable costs (€) | 28 800 | 33 900 | 31 600 | 37 000 | 95 100 | 109 900 | 90 400 | 89 800 |
| Fixed costs (€) | 58 900 | 60 700 | 45 800 | 46 900 | 96 900 | 98 700 | 90 100 | 91 000 |
| | | | | Marginal yields | | | | |
| Additional milk quota (€/t) | 272 | 109 | 187 | 0 | 217 | 0 | 193 | 97 |
| Additional milk yield (€/l) | n.c.[1] | 2 190 | 300 | 2 180 | 810 | 4 630 | 320 | 1 925 |
| Additional area (€/ha) | 187 | 163 | 412 | 408 | 585 | 622 | 418 | 397 |
| Additional building place (€/pl) | n.c. | n.c. | n.c | 1 545 | n.c. | 2 070 | n.c. | n.c. |
| Additional work hour (€/h) | n.c. | 43 | n.c. | n.c. | n.c. | n.c. | n.c. | n.c. |

[1]n.c.: not a constraint

The two diversified producers, *Milk+cereals* and *Milk+young bulls* farms, also have an income close to one another. Both farmers apply here a similar strategy of intensive production, the objective is to minimize the number of dairy cows in order to develop other activities. To do this, the milk yield of animals is equal to their genetic potential (8 500 and 9 000 liters of milk per cow per year). This level of production is reached through a massive use of concentrate feed. Thus, the *Milk+cereals* farm dedicates 72 % of land to the cereal production and the *Milk+young bulls* farm fattens 77 bulls in addition to the milk production. Lelyon et al. (2008) show that the full decoupling of the Special premium for bovine male in 2006 (210 €/bull) encourages producers to remove the fattening activity, because the profitability of this activity is in balance with grain production. In fact, this phenomenon has seldom been observed in France because, on the one hand, producers of young bulls were often engaged in contractual relationships with slaughterhouses and, on the other hand, most farmers do not consider not using their buildings to their full capacity even if it's more advantageous from a business point of view. For these two types of farming, the dual values of land and quota are positive. The marginal yield of the land is more than twice that of the milk. Increasing the productivity of dairy cows, constrained by the genetic potential, would also allow a significant increase in income.

None of the farms studied in this base situation is constrained by the nitrate directive whose dual value is zero: nitrogen pressure (total amount of organic nitrogen produced on the farm / total area) is below the standard of 170 kg/ha.

### *4.2. Abolition of milk quota: a high production potential*

Regarding the economic results, a 25 % increase of milk production leads to an income increase (12 % on average, see Table 2). However, the income increases proportionately less than the volume of milk produced due to an increase in variable costs (dairy cows, concentrate feed) and the crop-forage mix. The grazier farm is the one that better uses this extra volume because the substitution effects are lower than for the other farms. Thus, the quota rent of this farm is always the greatest (see Table 3). The long run quota rents are equal to zero for the *semi-intensive* and the *milk+cereals* farms because they cannot produce all the authorised volume, while those of the *grazier* and *milk+young* bulls farms are positive and represent more than a third of the milk paid price. The two farms still have room of manoeuvre to increase milk production. When we aggregate the four types of farming in order to represent the whole French dairy sector, the results are consistent with the other macro level studies about the implication of the milk quota abolition (Bouamra-Mechemache et al., 2008; Cathagne et al., 2006; INRA - University of Wageningen Consortium, 2002; Lips and Rieder, 2005; Wieck and Heckelei, 2007). The results seem to be a little high for the short and medium run quota rents compared to the Cathagne et al (2006) and Wieck and Heckelei (2007) results. At a long run scale, these results are close to those of Bouamra-Mechemache et al (2008), however their study shows that a phasing out of milk quota would lead to a very low quota rent for the producer (18€/t with 6% increase of quota, 4€/t with 12% increase of quota and zero if quotas are removed). Lips and Ridier (2005) also show that if the milk quota disappears, French milk production could only increase by 0.8 %. Those results are due to the fact that the French national quota was not entirely produced for 5 years showing that the quota was not a biding limit for the dairy producer. However, many farmers deliberately choose to not produce all their quota in order to avoid paying the financial penalty and also feeding and milking the cows to finally throw the milk in the gutter.

**Table 3.** Short run, medium run and long run quota rent estimation

| | **Short run quota rent** | **Medium run quota rent** | **Long run quota rent** |
|---|---|---|---|
| Grazier Farm (€/t) | 272 | 215 | 109 |
| *(% of milk price)* [1] | *91%* | *72%* | *36%* |
| Semi-intensive Farm (€/t) | 187 | 121 | 0 |
| *(% of milk price)* | *67%* | *43%* | *0%* |
| Milk+cereals Farm (€/t) | 217 | 97 | 0 |
| *(% of milk price)* | *78%* | *35%* | *0%* |
| Milk+young bulls Farm (€/t) | 193 | 124 | 97 |
| *(% of milk price)* | 69% | *44%* | *35%* |
| France [2] | | | |
| This study (€/t) | 209 | 122 | 34 |
| *(% of milk price)* | 74% | *43%* | *12%* |
| Cathagne et al (2006) | 175 | 104 | 4 |
| | *56%* | *33%* | *1%* |
| Wieck and Heckelei (2007)[3] | 178 | | |
| | *62%* | | |
| Bouamra et al (2008) | | 115 | 53 |
| | | *37%* | *17%* |
| Lips and Rieder (2005) | | | 68.2 |
| | | | *22%* |
| INRA Wageningen Consortium (2002) | | | 108 |
| | | | *35%* |

[1] The price of milk for each type of farming is given in the table 1

[2] The average quota rent for France is calculated according to the representativeness of each type of farming in France (given in Table 1). The four types of farming considered represent 78% of French dairy farms.

[3] Wieck and Heckelei give the short run quota rent for two French region (Britanny and Pays de la Loire). We give the mean of these two region in this table.

Of course, our study is only focused on the farmer's side and we do not take into account the price and demand change in response to such an increase of volume. The main fact that our simulation demonstrates is that all the farms studied have a strong potential for milk production. The main reason for this potential stems from the fact that the growth rate of the agricultural area for dairy farms was twice that of the quota per farm over the last ten years. In France, milk quotas are linked to the land and farmers need to rent or buy additional lands to increase their quota. There was, therefore, an extensification process of milk production in France characterized by a low milk productivity per hectare of land (4 000 liters/ha against 8 800 Denmark or 11 500 in the Netherlands). In order to use these additional areas, farmers developed alternative activities such as fattening or cereals production which they can easily reduce or remove in case of an abolition of milk quotas.

However, the abolition of milk quotas creates a strong incentive for the intensification of production system: the quantity of milk produced per hectare of forage area strongly increases. This increase in level of production has a negative impact on environmental criteria. Indeed, even if the farms do not reach the maximum level of nitrogen discharge permitted by the nitrate directive, the nitrogen pressure increases. Similarly, the use of chemical nitrogen highly increases for the *Grazier* farm and to a lesser extent in the *Milk+Young bulls* Farm: fertilization of grassland is more intensive in order to increase yield. Furthermore, the quantity of concentrate feed consumed also rise and makes farms more dependent from purchased feed and thus more vulnerable to price variations.

Looking at more precisely how each type of farming reacts to the removal of milk quota, we see that two farms can produce the maximum volume allowed (+25%), with the same farm structure, i.e. without making any investment: the *Grazier* and the *Milk+young bulls* farms (see Table 2). These two farms have indeed the ability to easily increase their milk production by intensifying the production system. For the grazier farm, this increase in volume is mainly enabled by increasing milk production per animal (+17% up to 6 150 l/year ) made possible by increasing concentrate feed. The production of the additional volume of milk is then achieved through a small increase in the number of dairy cows. To facilitate this transition, the farmer chooses to no longer feed his calves with home produced milk, but now uses milk powder (which represented an annual volume of milk of 12 600 liters or 2.1 cows). The situation of the *"Milk + Young bulls"* farm is different because this farmer can only increase a few the milk yield per animal which has already reached the limit (9 000 liters per cow per year). However, this farmer can use part of the fattening building for dairy cows. Thus, the farmer increases milk production by replacing bulls by dairy cows. Moreover, he also chooses the milk powder to feed calves and thus saves more than 40 000 l per year.

The "*Semi-intensive*" and "*Milk+cereals*" farms do not achieve the additional 25 % of authorized volume. They are limited by the number of places for cows in buildings. This constraint is then lifted to enable the farmer to expand the cowshed in order to increase milk production (the cost of one place in the building is about 4 000 € per cow: 330 € per cow with a 12 year amortization). In this case, the *Semi-intensive* needs 5 additional places to reach the threshold of +25 %, while leading to an increase of 6 % of income. The *Milk+cereals* farm needs 4 building places, thus generating 1 % of additional income.

To feed the additional animals, farmers change the crop rotation: the share of fodder crops increases at the expense of cereal crops (except for the Grazier farm which had no cereals). This increase in forage area consists in equal part of an increase in the surface of grassland and maize. The full decoupling of the crops premium (which benefited maize silage) re-balances the choice between grassland and maize (Ridier and Jacquet, 2002). It is also important to note that the removal of set-aside, already included in the baseline, limits the process of intensification, freeing land for fodder crops.

Among the constraints limiting the increase in milk production, the milk productivity per animal has the greatest impact on income. Indeed, when farmers manage to increase the milk yield by one liter of extra milk per cow per day, it generates an income increase from 1 900 to more than 4 500 € depending on the farm. It is the economic gain enabled by the animal genetic level. Cows which have a higher potential can produce more milk at a lower cost: fewer animals for the same quota, thus freeing areas for other activities. Naturally, such conclusions depend on the relative prices of milk, cereals and meat.

Results are now discussed considering several hypotheses regarding price fluctuations for milk and cereals. In these simulations the price of concentrate feed is indexed to the price of cereals. It appears that maintaining milk production is always a priority for farmers, regardless of the price considered. Indeed, the costs incurred to establish a dairy operation are often too high for farmers to consider abandoning milk for cereal production. This is especially true because the agricultural area of dairy farms is often far below the threshold of profitability traditionally met in the specialized crop farms. For the *Milk+Cereal* farm, the total removal of dairy activity in favour of cereals would be, theoretically, possible in the unlikely event that the price of milk reached 230 €/t while cereals peak at 240 €/t (see Figure 1). Nevertheless, the simulations are run with constant fixed costs. The decision could possibly be different for a farmer with no more building depreciation or who has no loans outstanding. Location in a plain region with high agronomic potential land and/or a generation change (setting up of a new farmer) could also lead to abandoning milk production since it is very time restrictive (milk the cows 365 days a year, twice a day).

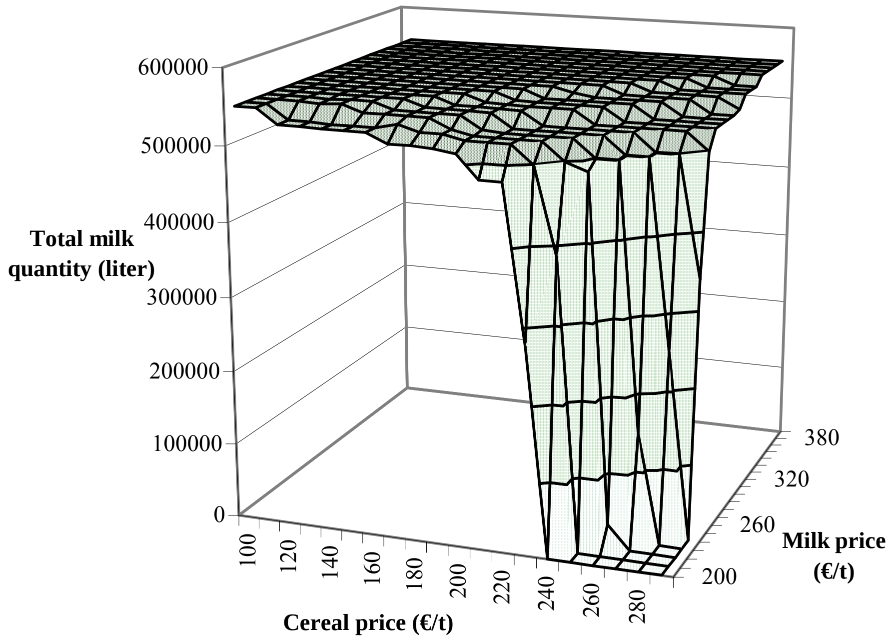


**Figure 1.** Total milk production according to the milk price and cereal price (milk+cereal farm)

If the farmers' strategy is to maximize milk production (regardless of the milk price), the price level of cereals has an impact on the rotation through a change in the share of cereals in the total agricultural area at the expense, or benefit, of forage areas (see Figure 2). Regarding the feeding system, these rotation choices lead to, assuming an increase in grain prices, an increase of maize silage in the diet (and therefore to an accentuated use of concentrate feed). For the *Milk+Young bull* farm, the room to manoeuvre is more important concerning the rotation because this farmer can decide, if necessary, to reduce the number of young bulls.

When the cereal price is below the threshold of 130 €/t, cereal production is declining and even abandoned in two types of farming (*Grazier* and *Milk+young bulls*). The rise in the price of nitrogen fertilizer also causes farmers to adopt this strategy.

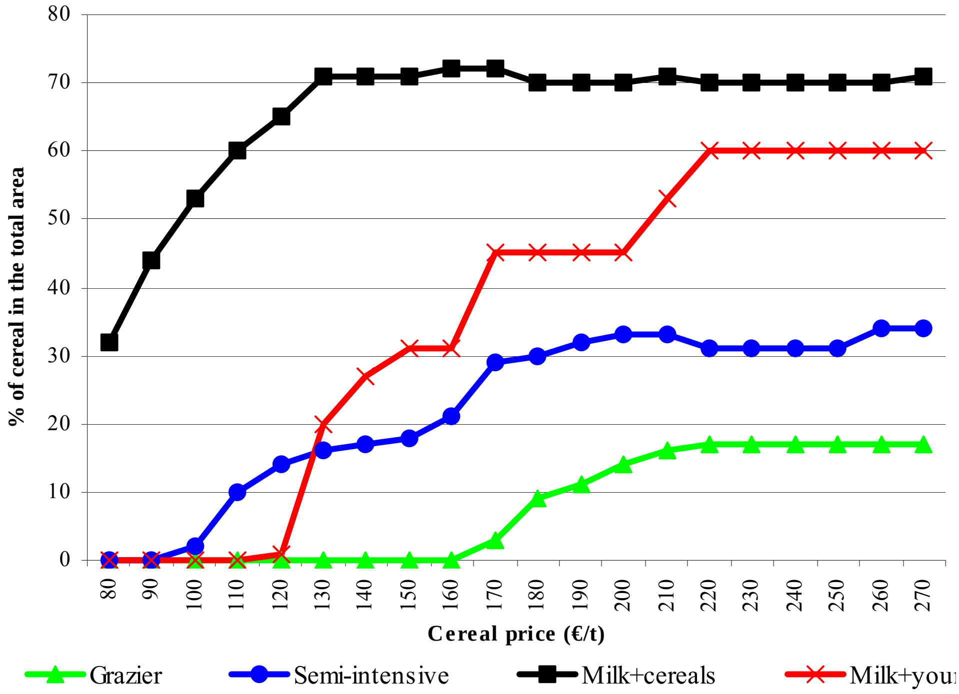


**Figure 2.** Proportion of cereals in the agricultural area according to the cereals price

## 5. Discussion and conclusion

This model, based on the mathematical programming methodology, assesses the impact of the abolition of milk quotas on the productive strategies of French dairy farms. Because we consider the interactions between types of production (both plant and animal), the main laws of biological response and the seasonality of agricultural production, this model represents, as realistically as possible, farmers' behaviour and supplies economic, technical and environmental response to the abolition of milk quotas. Based on the current construction, some improvements are possible such as to integrate other goals in the objective function (such as minimisation of labour). In a context of increased volatility in prices, the UEP method could be modified to better integrate farmers' expectations facing the direction (positive or negative) of price changes.

For dairy farmers, the abolition of milk quotas is naturally the most important issue among the various measures of the CAP "Health Check". All things being equal, and whatever the price of milk or cereals, milk producers always try to attain the maximum volume of milk production allowed. The fluctuation of cereal prices however impacts the rotation and the level of intensification. These simulations mainly emphasize that dairy farms have a high potential for increasing dairy production with constant fixed costs. However, the rise in production is mainly possible by an strong intensification of the farming system which has some negative impacts on the environment (nitrogen discharges) and the feeding self-sufficiency (more concentrate feed purchased). In the simulation, the increase in production has been limited, by hypothesis, to 25 %. A significant fraction of milk producers would be able to produce more if the authorization was given. This applies primarily to farmers located in areas where environmental restrictions are not too important and those for whom land is readily available. Indeed, the potential development of milk production is not homogeneous according to regions and often depends on the parallel presence of other livestock activities (pigs and poultry).

In France, more than in other Member States, the abolition of milk quotas raises significant questions. The management of the quotas allows a large state intervention in the geographical distribution of production. Moreover, milk price partly reflects the close cooperation between producers and dairy processors. In case of removal of milk quotas, companies will likely have a stronger power in the pricing of milk, the milk quality requirement, the orientation of the structure (size, intensification) and the location of the supply. Future productive strategies of French dairy farms will not only be influenced by changes in relative prices (input and output), but also by the terms of the contracts with companies.

Whatever the ways to end the milk quota system, European and French dairy farms will continue to benefit from an interventionist agricultural policy. In New-Zealand, Australia and Argentina, three major exporting countries, the dairy sector benefits from a low public support, weak border protections (or non-existent) and a very competitive production cost per ton of milk. In the United States, a country with a rapid growth of its domestic production (unlike the European Union), the dairy sector is supported by a strong market intervention. An increasing share of milk production comes from very large farms which are hardly comparable to those encountered in the European Union. The instruments used to support milk production in the European Union would therefore, despite the abolishment of milk quotas, stay quite specific in the next decade.

## Acknowledgements

We would like to thank seminar participants at "*The CAP after the Fischler reform: national implementation, impact assessment and the agenda for future reform*" (109$^{th}$ EAAE Seminar, Viterbo, November 2008) and at the second *INRA - SFER – CIRAD* conference (Lilles, December 2008) for valuable comments on earlier versions of this paper. This paper also benefited from comments by J. Scott Shonkwiler visiting researchers INRA-Nantes. This research was funded by the research programmes: "Laitop" (PSDR Grand-Ouest) and "Dynamics of Dairy Territories in France and Europe" (funded by CNIEL, Crédit Agricole, FESIA, Groupama and SEPROMA).

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