Decoupling and prices: determinant of dairy farmers' choices? A model to analyse impacts of the 2003 CAP reform

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Abstract— **The reform of European Common Agricultural Policy (CAP) in 2003 has resulted in substantial changes to the attribution of subsidies to dairy farmers. Moreover, dairy farmers are in also facing an unprecedented situation on the markets with the soaring prices of agricultural raw materials: they sell their products at a higher price (milk, meat and cereals), but must also cope with the increasing prices of concentrates. In this paper[1], we discuss cross effects, on the productive strategy of French dairy farms, of the Luxemburg Agreement and the prices variations. A model based on mathematical programming has been privileged to determine how dairy farmers might re-evaluate their systems to identify optimal production plan. While respecting the principle of agent rationality (maximization of profit), the model incorporates the economic risk related to the volatility of the inputs and outputs prices. Thus the model maximises the expected utility of the income while taking into account a set of constraints: regulatory, structural, zootechnical, agronomic and environmental. The model is applied to four types of dairy farms to cope with the diversity of production systems in the west of France ("grazier" type, "semi intensive" type, "milk + cereals" type and "milk + young bulls" type). The model is used to produce quantitative estimations and support reflection through the simulation of the setting up of the Single payment scheme. The sensitivity of the results is discussed by taking into account several options of prices for cereals and livestock products. These may have a strong influence on the structure of the diet and, therefore, on the level of intensification of the forage area. The results show that the implementation of the CAP reform encourages farmers to substitute a part of corn silage by grass in the diet. However, the rising price of agricultural production encourages, on the contrary, farmers to intensify their system in order to free up land for growing cereals. We also observe that a decrease of the young bulls fattening activity to develop cereal crops is also economically profitable.**

Keywords— **dairy farm, single payment, price variation**

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I. INTRODUCTION

Dairy farmers, in 2007, are facing an unprecedented situation on the markets with the soaring prices of agricultural raw materials. This can lead them to change their production system in order to take advantage of this favourable economic situation. For French farmers, these changes occur simultaneously with the implementation of the reform of the Common Agriculture Policy (CAP), decided in 2003. A key driver of this reform has been the recent World Trade Organisation (WTO) Doha round of negotiations. Three innovations were introduced: i) the decoupling of direct support based, in France, on the amount of direct subsidies received in 2000-2002 (historical approach). ii) the dairy Common Market Organisation is modified: the intervention prices of industrial dairy products (butter and powder) are reduced and subsidies are granted to farmers according to their dairy quota. iii) a part of the direct subsidies are deducted from the first pillar of the CAP to abound to the second pillar (modulation system).

In this context, the aim of this article is to study the dairy farmer's behaviour relating to the CAP reform with different hypothetical prices. A Linear Programming (LP) model is used and applied to French dairy farms from western regions (Basse-Normandie, Bretagne and Pays de la Loire). These regions represent 45% of French milk production and 8% of European (EU-27) milk production [1]. The farms of this region are diversified and often have, in addition to the dairy activity, cereal or beef production. Four technical systems are considered in this study according to the intensification of forage area and the level of specialization. This method enables a representation of the system at farm level with a high level of accuracy. According to the criteria established by Janssen and van Ittersum (2007) [2] this model can be classified as a bio-economic farm model: it pays particular attention to the interactions between the feeding system and the management of land and also to the farmer's sensitivity to price changes.

This paper is divided into two parts. In the first part, a description of the mathematical model is proposed ; in the second part, some simulations are made to analyse the impact of the CAP reform on the dairy farms. They try to give arguments around these three following questions: i) How do the CAP reform and the agricultural prices variations influence dairy producers' income? ii) How does the decoupling change the interest for different kinds of productions in a dairy farm? iii) How could the regionalization of the single payment modify the farmers' strategies?

II. MATERIALS AND METHODS

This first part presents the mathematical model built which is applied to the dairy farms from the West of France. Some general considerations are first made of the linear programming in order to better understand its advantage and limits ; then the four selected types of farming are introduced ; the model is finally developed.

A. Linear programming: a farm level approach

LP is a mathematical technique, which enables us to represent the farm functioning in reaction to a set of constraints. LP has long been used as a farm analysis tool because its hypotheses correspond to those of classic micro economy: rationality and optimiser nature of the agent [3]. This method has several limitations that are inherent to the hypothesis of this technique: the yields of the production factors are linear, the producers act in a situation of perfect information and adjustments between the production factors are instantaneous. However, the strength of this approach is to represent precisely the productive complexity of the farm. It also allows us to study the threshold effects and to calculate dual values of production factors.

Farm-level modelling enables simultaneous considerations of production, price and policy information. LP can: (i) incorporate new production techniques by adding new activities, (ii) add agricultural and environmental policy by including new restrictions in the model or by putting levies on undesired outputs [4]. Farmers as well as governmental institutions can benefit from these calculations. Farmers get more insight into the possibilities of reacting to changing policies, and governmental institutions get an impression of possible effects of proposed policies.

This work has a different objective, the model built tries to understand and anticipate the implications of CAP modification on dairy farmer behaviour. This model should help us to show if the Single payment scheme (SPS) facilitates reaching the objective of the reform. Appropriate selection of holistic management strategies for livestock farming systems requires: (i) understanding of the system as a whole in its agro-eco-regional context; (ii) understanding of the behaviour of, and interrelations between, the different parts of the system; and (iii) knowledge of the basic objectives of the decision maker managing such an enterprise [5].

Any model derived from linear optimisation has three basic elements [6]: (i) an objective function, which minimises or maximises a function of the set of activity levels; (ii) a description of the activities within the system, with coefficients representing their productive responses; and (iii) a set of constraints that define the operational conditions and the limits of the model and its activities. Linear programming presents a collection of relevant technical opportunities offered to the farm by separate activities in a matrix. The rows in this matrix form the constraints that represent the technical relations between the activities. Given the objective function, the solution procedure determines the optimum solution considering all activities and restrictions simultaneously. Marginal product values of the resources are part of the solution and ease interpretation of the results.

B. One model for four types of farming

In order to represent the diversity of farms in the West of France, the model integrates four different "types of farming". The West of France is composed of 42,000 dairy farms which cultivate 63% of the regional usable agricultural area (Perrot et al., 2007). The average size of farms (243,000 litters of milk quota) is smaller than the other dairy farms in the European Union (279,000 litters of milk quota).

1. *"Grazier farm"* is a 77 ha family farm with 255,000 litters of milk quota [7]. It produces milk with a large part of grass, which provides high food autonomy. The milk yield per cow is low (5,000 litters per year) but the prices of milk and meat are higher thanks to a better milk composition and heavier carcasses (Normand cow). The age of first calving is 30 months and the calving period is in the Spring. Cows are housed for 4 months while they consume maize.
2. *"Semi-intensive farm"* is a 50 ha family farm with 295,000 litters of milk quota. It is the most representative system of the area: 32% of dairy farms in the Farm Accountancy Data Network (FADN) in the West of France. The calving period is in the Autumn, that's why the use of maize is higher. The cows are more productive: Prim' Holstein with a milk yield of 6,500 litters per year and an age of first calving of 24 months.
3. *"Milk + cereals farm"* is a highly intensive system with 137 ha and 460,000 litters of milk quota. Each cow can produce 8,000 litters per year, consequently the use of maize in the ration is not limited. Dairy production is the main activity on the farm, however cereal crop activity is developed in parallel.
4. *"Milk + Young bulls farm"* has 100 ha and 400,000 litters of milk quota. It has the same characteristics as the previous type of farming but in this one, young bull fattening activity replaces the cereal activity.

C. The model

Optimisation of the Gross Farm Excess. The model optimises the farm plan, which represents the quantities of different outputs produced and factors used, and furthermore, it provides relationships between inputs and outputs. The farm economic results follow from the quantities of inputs and outputs and their prices, and give an indication of the production's profitability and of the farm's income. The model is used to determine the effects of institutional, technical and price changes on the farm plan, economic results and intensification indicators [8].

The central element in the LP model is the dairy cow. The model represents the functioning of the farm for a one-year period. The duration of the lactation is 305 days long for all the cows, but the fecundity rate is lower for the most productive cows ("Milk + cereals" and "Milk + Young bulls" farms) decreasing, as a result, the number of calf per cow per year. At the end of the lactation, cull cows are sold and benefit from the female slaughter premium. Regarding the progeny, it is assumed, according to the intensification level of the type of farming, that 25% to 35% dairy cows are replaced per year by heifers raised on the farm [7]. Concerning the females which are not assigned to replace cows, the model can choose between: (i) selling the calves at the age of 8 days, (ii) keeping the calves until 2 years old and sales to the slaughterhouse (with the female slaughter premium). For the "Milk + Young bulls" farm, the model can choose to fatten (or not) the males and buy (or not) others male calves to reach 80 young bulls. These animals are slaughtered when they are 20 months old. The young bulls benefit from the male slaughter premium (80€/animal) and the special premium for male bovine (110€/animal). Specific costs are considered for each type of animal: artificial insemination, medicines; herd book, performance collecting, straw, minerals and other animal costs.

Regarding the vegetal productions, the forages produced in the West of France are mainly maize silage, grass silage, hay and pasture. All farmers aim for forage self-sufficiency, the purchase or sale of forage are eliminated, which are rare activities linked to exceptional events (e.g., drought or exceptional harvest) in these areas. For the cereal crops, each type of farming can produce wheat but the "Milk + cereals" type of farming can also produce rape, maize and pea. This farm has to agree with some crop rotation constraints (alternation between the Winter and Spring crops). Farmers must comply with the set-aside's criteria in order to benefit from crop premium. It is assumed that these productions are sold at the harvesting time, there is no stock except for the wheat which can be used to feed the cows: the total cost is the cost of production per hectare plus the storage and grain milling costs. Crop productions have one level of nitrogen use, but the yields are different according to the types of farming and its level of intensification.

As well as animal production, specific costs are also allocated for each type of crop: seed, fertilisers, treatments and harvesting.

With these elements, the objective function of the model maximizes the Farm Gross Excess (FGE):

FGE = Output vegetal production – specific vegetal costs + output milk + output meat – specific animal costs – concentrate feed + subsidies (crop, set-aside and animals) – fixed costs (mechanisation, buildings, rent paid for land, farm taxes, interest paid, other fixed costs)

This objective function incorporates neither bank interests nor depreciation. It is therefore not possible with this model to simulate structure changes such as investments or expansion.

The model will therefore determine the optimum composition of the herd, the distribution of crops and food intake in order to maximize the farm's income. The set-aside decision is also an endogenous variable. As Ridier and Jacquet (2002) [9] state, it is integrated as a binary variable which is 0 if the farmer does not make the decision and 1 if he does.

The interactions between forage system and animal production. Thornton and Herrero (2001) [10] show that a wide variety of separate crop and livestock models exists, but the nature of crop–livestock interactions, and their importance in farming systems, makes their integration difficult. In order to precisely describe the interactions between forage system and animal production in dairy systems, this model consists of four key components:

1. A particular attention has been paid to the feeding system. The quantity ingested per cow per day is determined by using (i) nutritional requirements in energy and protein [11,12] and (ii) the composition of forages and concentrates according to the Unit Feed Lactation system [13,14]. Home-produced forages available in the model are pasture, grass silage, hay and maize silage. The purchased feeds are soybean, rapeseed meal, wheat, production concentrate and milk powder (for calves). The model has the possibility to use wheat and milk produced on the farm. This model also includes a requirement concerning the structure of the ration, i.e. the equivalent of effective fibre in long roughage, is incorporated. At least one-quarter of the dry matter of the ration must consist of structural material to avoid acidosis [15]. Moreover, animals cannot ingest food more than their intake capacity.
2. The model proposes two separate units: the area of production (in hectares) and the volume of production (in kg) that is the yield for each crop, in order to take account this multiple production of the same unit area. Grassland is a specific forage: it can produce grass, hay and silage on the same surface and in the same year.
3. Four periods (Spring, Summer, Autumn and Winter) are distinguished in the model. It allows introducing seasonal specifications to grass production and grassland use [16]. Seasonal variations enable to integrate differences in growth potential of grass during the growing season as well as the evolution of nutrient content of grass. The model shows a better ability of prediction thanks to the addition of these new parameters.
4. The milk production per cow is not fixed in order to give more flexibility to the model. Farmers have the possibility to reduce or increase milk production by modifying the feeding system (with more or less concentrate). The model can set the milk yield per cow in a range of 1,500 litters. Then the model is calibrated to correspond to the observation for each type of farming.

Consequently, milk production, feeding requirements and grass production are assessed for each period. Thanks to the dissociation between surface and quantity for crop production, the model reproduces an optimal production plan which is well-fitted to dairy food system.

The constraints. The set of constraints consists of requirements related to the farm structure, biological rules, production techniques, environmental and political regulations.

Technical and structural constraints. The model takes the demographic equilibrium of the herd into account: the cows give birth to 50% of males (sold at the age of 8 days) and 50% of females which are reared according to the restocking rate. Buildings are mainly free-stall housing in which the number of places is flexible according to the age of the animals. The only building constraint integrated into the model is the number of places available for the cows. It is assumed that the number of cows can increase by 10%: the application of the Global monitoring for environment and security (GMES) 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 preceding crop and the conditions for income support for cereals and set-aside. The “Milk + cereals” farm has two more constraints in order to obtain a farm structure which conforms to reality: the total forage area must be lower than 35% of the total farm area and the corn area must be lower than 50% of the total forage area. Of course, the sum of crop area has to be lower than the total available area and the total volume of sold milk has to be lower than the quota. The farm structure is fixed to analyse the adaptation of dairy farmers to the reform without other factors.

Respect for the environment. The CAP reform of 2003 places environmental respect as one of its first objectives with the setting up of the cross compliance measures such as water resource management, food safety, animal and plant health, animal welfare standards and sustainable development. To avail of various government grants and EU premiums and to be compliant with legislation, farmers must operate within codes of good practice. The main environmental measures included in the model are: i) The European Council directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (No: 91/676/ EEC) requires measures be taken in respect to farm practices. Farmers cannot exceed organic nitrogen application rates of 170 kg nitrogen per hectare; ii) the measure requiring farmers 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, 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. This premium (75€/ha) finances the “grazier farms” which are less productive but more environmentally friendly.

Seasonal Labour. Labour constraints are introduced by allocating labour needs to each activity. Agricultural labour is not regular over the year. Because we distinguish four periods in a year, we can integrate the work peaks (harvesting and calving time). However the difficulty is to quantify the labour needs of each activity. Labour data used in the model are based on studies carried out by Caramelle-Holtz et al. (2004) [17] on labour use on French dairy farms. A constraint on available farmer and family labour is included. It is assumed that the farmer and his family/associates execute all the work and thus there is no option to hire temporary labour. Silage harvesting and slurry spreading operations are assumed to be carried out by agricultural contractors.

The calibration step is very important : the model’s results and the empirical observations have to be close. Results were compared to four key points: percentage of cereal crop area, percentage of corn area, milk yield per cow per year and the ratio gross farm excess / total output. These data come from a network of 640 dairy farms [7] and from the FADN. We consider the solutions to be representative of the cases studied when all four key criteria were very close to reality.

The price variations: how to take risk into account? During the year 2007, prices of agricultural commodities have been subject to strong variations. For example, the price of industrial dairy products such as skim milk powder (0% fat) has nearly doubled through 2007, from 2400 €/t in January to 4000 €/t in August. It stabilized at 2300 €/t in December [18]. Prices of cereals such as wheat and corn doubled in 2007, from 125 €/t in January to 250 €/t in December. Cereals play a special role in dairy farming: they are both input and output. Increasing the price is favourable to crop production but, on the other hand, is negative for the food cost (concentrates). Many studies have demonstrated that farmers typically behave in a risk-averse way [19]. As such, farmers often prefer farm plans that provide a satisfactory level of security even if this means sacrificing income on average.

In order to obtain reliable predictions, the modelling of farmers’ responses to policy changes must consider the risk associated with any given cropping pattern: the predictive ability of the traditional profit maximization model is very low. Many studies have demonstrated that farmers typically behave in a risk-averse way [20]. As such, farmers often prefer farm plans that provide a satisfactory level of security even if this means sacrificing income on average.

To incorporate risk-averse behaviour in the mathematical programming models the Mean – Variance method is used: this technique can easily be incorporated in a LP setting. This method is based on maximising the farm gross excess while minimizing the risk. Mathematically this is formulated as follows:

$$Max: \quad F = \mathrm{E}(\mathrm{Z_e}) - \Phi \,.\, \sigma\ (\mathrm{Z_e}) \tag{1}$$

$$\text{with: } Z_e = \sum_j c_{je}\ \mathrm{x_j} \tag{2}$$

$$E(Z_e) = \sum_{\mathrm{j}} \sum_{\mathrm{e}} \frac{\mathrm{c_{je}\ x_j}}{\mathrm{e}} \tag{3}$$

$$\sigma\ (\mathrm{Z_e}) = \sqrt{\frac{\left[\mathrm{Z_e} - \mathrm{E}\ \ (\mathrm{Z_e})\right]^2}{e}} \tag{4}$$

where: **E** is the Expected value, ***e*** each state of nature, $\mathbf{Z_e}$ the average income per state of nature e, $\mathbf{c_{je}}$ is the average gross margin per output unit for the activity j and per state of nature *e*, $\mathbf{x_j}$ the quantity of output for the activity j and **Φ** is the risk aversion coefficient

To maximise the objective function F, the model minimises σ (Ze) which is the income deviation. This approach is flexible in avoiding too rigid specification of the utility function. Further, if other socio-economic factors enter the utility function in addition to mean and variance, the farmer is free to choose the plan he most prefers in relation to a multiplicity of goals [3].

In the model the input prices (concentrates and milk powder) and the output prices (meat and cereals) are subject to variations. The milk's price is fixed because it is an institutional price. The price variations come from the GOAL model [21] which is a calculable general equilibrium model representing the agricultural sector in the EU. It is difficult to know whether the situation on the markets will be prolonged longer. That is why, the price of wheat used for the simulation is 180€ per ton, while the market price is 240€/t in February 2008.

III. RESULTS AND DISCUSSION

The Luxembourg Agreement should encourage farmers to choose their production towards the needs of the markets and the demands of the consumers by following market signals: prices [22]. And according to the Uruguay Round Agreement the amount of single payments in any given year shall not be related to, or based on, the factors of production employed in any year after the base period [23]. In other words, farmers are no longer bound to produce to receive the payment.

The model gives the opportunity to study the impact of the CAP reform on the economic performances of farmers and their productive choices: arbitration between animal and vegetal production, intensification or extensification strategy. We also study the dairy farmers' behaviour in a favourable price situation.

A. The CAP reform: a stable income

The first item discussed concerns the impact of the CAP reform on the economic performance of the farms studied. In France, the decoupling is partial: crop premium is partially decoupled (75%) as well as the slaughter premium (60%) and others animal premiums (suckler cow, ewe) ; but direct subsidies based on the milk quota, special premiums for bovine male (SPBM) and set aside premiums are totally decoupled. Theoretically the decoupling of aids has no effects on income because it does not affect the amount of subsidies, only the method of assigning is different. However, decoupling can urge to change production activity by making some products less attractive than before.

We compare the baseline 2003 (with subsidies linked to the production factors: land and livestock) to the 2007 situation incorporating of the decoupling, the modulation of subsidies and the obligation to maintain the surfaces in permanent pasture. To isolate the effect of the reform, the price levels of productions and inputs are maintained stable between the two situations.

Table 1. Implementation of the CAP reform taking into account the prices' increase

	Grazier Farm			Semi-intensive Farm			Milk +cereals Farm			Milk +Young bull Farm		
	2003	2007	2007 (price increase)	2003	2007	2007 (price increase)	2003	2007	2007 (price increase)	2003	2007	2007 (price increase)
FGE (€)	55 000	54 800	61 800	57 200	57 500	61 000	125 000	123 200	148 600	104 400	118 700	142 400
Crop area (ha)												
Grain prices (€/t)	118	118	180	118	118	180	118	118	180	118	118	180
Cereals	11.0	7.6	13.4	11.4	7.3	11.4	77.7	77.9	77.9	17.0	59.7	60.4
Corn silage	5.7	4.5	5.8	15.1	11.8	15.1	24.0	15.4	22.2	54.9	21.5	21.6
Grassland	60.3	64.9	57.8	20.6	28.0	20.6	24.0	32.6	25.7	20.1	10.8	10.0
Set-aside				2.9	2.9	2.9	11.3	11.2	11.2	8.0	8.0	8.0
Premium for grassland	yes	yes	yes	no	no	no	no	no	no	no	no	no
Animal activity												
Dairy cows (nb.)	53	54	51	46	46	46	57	50	57	51	45	45
Young bull (nb.)										78	0	0
Milk yield (l/year)	5 580	5 550	5 800	6 600	6 600	6 600	8 200	9 500	8 200	8 800	9 000	9 000
Milk l/ha forage area	4 300	4 100	4 500	8 100	7 300	8 100	9 600	9 600	9 600	5 300	12 400	12 700
Concentrates (kg/year)	310	340	370	1 040	1 000	1 100	1 200	1 900	1 200	1 340	1 440	1 400
Nitrogen produced (kg)	6 770	6 800	6 500	5 250	5 250	5 200	6 500	5 600	6 500	10 400	5 100	5 100
Working time(h/awu/year)	1 970	1 960	1 920	1 980	1 940	1 980	2 220	1 960	2 200	2 140	1 300	1 300
Economic results												
Total output (€)	142 800	140 100	154 500	138 400	133 300	147 100	290 500	285 000	324 300	280 300	258 200	292 900
Milk output (€)	86 100	82 500	84 000	81 600	80 700	81 100	104 700	119 440	120 500	85 200	123 800	125 400
Meat output (€)	29 900	28 500	31 700	22 200	21 200	28 700	24 100	19 600	26 000	110 300	17 800	20 400
Crop output (€)	13 800	6 500	16 200	22 000	9 200	20 000	117 000	88 700	119 800	46 500	67 400	97 900
Total subsidies (€)	13 000	22 600	22 600	12 600	21 600	22 300	44 900	57 300	58 000	38 300	49 200	49 200
Variable costs (€)	33 600	31 900	35 200	37 700	33 700	40 300	80 200	77 800	82 400	96 000	67 200	70 000
Fixed costs (€)	54 200	53 400	57 500	43 500	42 100	45 800	85 300	84 000	93 300	79 900	72 300	80 500
Marginal yields												
Additional milk quota(€/t)	197	182	159	142	115	88	197	157	144	186	147	130
Additional milk yield (€/l)	n.c.[1]	n.c.	n.c.	592	447	683	-185	97	-43	n.c.	222	166
Additional area (€/ha)	129	65	230	428	328	561	372	247	502	488	236	578

[1]n.c.: not a constraint

The implementation of the CAP reform has very little influence on economic performance (see Table 1) for the first three types of farming (excluding the young bull production). The gross farm excess is stable, for two reasons. The modulation of direct aid of 5% decreases the total output but this is partly offset by a decrease of variable costs (the grazier production is cheaper than a silage based production). Even if income is stable, the weight of aid in the income rises strongly. The amount of subsidies rises by 70% for the grazier and semi-intensive type of farming with the importance of the dairy production in relation to the total production. The CAP reform increases the dependence of farmers on direct public support as showed by Chatellier (2006) [24]. There is also a great disparity between intensive and extensive systems: farms with cereal or fattening activities perceive the largest amount of subsidies.

The decoupling causes a significant decline in marginal yields of an additional litter of milk quota (from –8% to –20% depending on the type of farming) and an additional hectare of land available (from –20% to –50%). Regarding milk marginal yield, the work of Moro et al. (2005) and Bouamra-Mechemache and Réquillart (2006) [25,26] within the framework of European Dairy Industry Model project, confirms these results. The estimated marginal costs (per tonne of milk) by their calculable general equilibrium model range between 141€/t to 163€/t (50% of the price of milk) for the Western French dairy farm after the CAP reform. Nevertheless these marginal yields remain positive and, consequently, expanding the farm is economically beneficial.

Then, we simulate the reform with the rise of prices between 2003 and 2007. The increase in agricultural prices in the model is: from 2.2€ to 2.7€ per kilo of meat for cull cows; from 2.4€ to 2.75€/kg of meat for young bulls; from 118€ per tonne to 180€/t for wheat; from 115€/t to 180€/t for corn and from 140€/t to 220€/t for the energetic concentrate. The price of rapeseed and soybeans remained stable at 180 and 220€/t respectively. This increase of agricultural production prices improves the farm gross excess for all the types of farming studied from 7% to 36%. (see Table 1). This situation, very economically beneficial for the farms, helps to reduce the part of aids in the income.

B. More grassland?

Then we study the use of land with the implementation of the reform. We pay special attention to the allocation of forage area including distribution between silage maize and grasslands (intensification strategy versus extensification strategy) with the partial decoupling of the crop premium in France.

The implementation of the reform leads to extensifiying dairy production with a decrease of cereal crop and silage maize and an increase of grassland (for the grazier, semi-intensive and milk + cereals types of farming ; see Table 1). The decoupling of 75% of crop premium (corn silage included) rebalances the choice between grass and corn but is not enough to encourage farmers to comply with the criteria for the premium for grassland (the grazier farm is the only one to benefit from this aid). Regarding environmental criteria, with the increase of grasslands, the measure of maintaining surfaces in permanent pasture is never a constraint. This is also the case for the implementation of the Nitrates Directive, which is not a constraint for farms.

However, many farmers will continue to focus on corn: feeding management of the herd based on grass is more complex (nutritional values constantly change). Moreover, the labour constraint may curb the use of pasture, it requires driving the animals to the plots and bringing them back for milking [27]. Similarly, the larger use of milking robots requires grassland around the robot, which must be accessible at all times.

But in the more favourable price conditions of 2007, farmers seek to increase their cereals production. They increase the share of corn silage in the diet as well as the quantity of concentrate distributed (+20% for the typical case grazier) to achieve a higher milk yield in order to free up land. Thus, farmers convert into cereals surfaces they had previously released to grasslands (see Table 1). The decline in gross margin of crop productions caused by the decoupling is offset by the rise in prices: the marginal yield of an additional hectare of land increase of 33% (and 78% for the “grazier” farm). The gains generated by the cereal production are higher than the savings arising from a grass-based milk production.

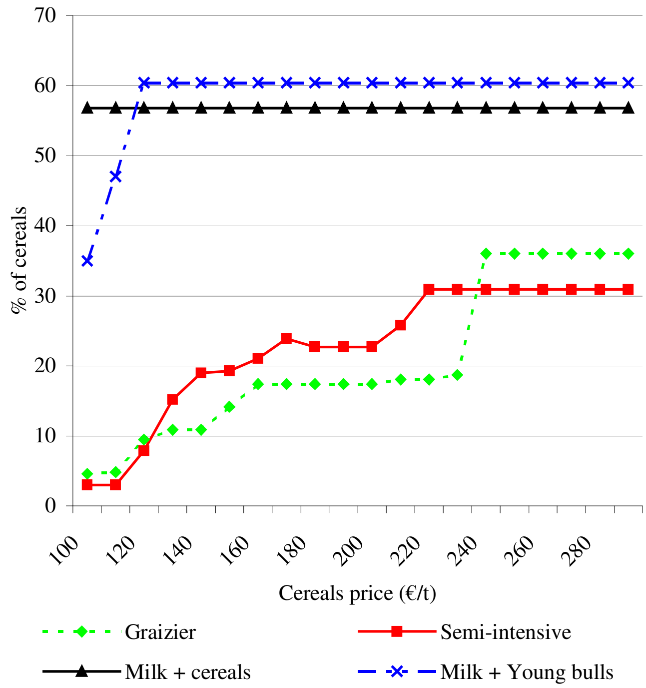

Fig. 1 Evolution of the part of cereal in the total area according to the cereals price

The model therefore proposes a production system next to that of 2003 (distribution of crops and livestock composition).

The Fig. 1 shows that all types of farming increase the part of cereal in the total area when cereals price increases (except for the "milk + cereals" farm which has special rotation constraints). At the same time, all types of farming reduce the share of grass in the diet of dairy cows and replace it by corn silage to intensify milk production. The intensity of this decline depend primarily on the yield and on the production cost of cereal crops and corn silage. We can also see that the "grazier" farm choose to no longer meet the criteria of the "premium for grassland" when cereals price exceed 230 €/tonne.

As we can see, the increase of cereals price encourages farmers to develop these crops. However, milk production is still the most economically advantageous since the price of wheat must be higher than 360 €/ton to become the most profitable production.

C. The decoupling: cessation of the fattening activity?

In this section we are especially interested in the young bull fattening activity. Indeed, the premium for these animals (SPBM) is totally decoupled leading to a decrease in gross margin per animal of 210€ (plus 48€ for the slaughter premium). Our question focuses on maintaining this production which benefited previously from large amounts of aid. The model is used to determine the arbitration of the farmer in this situation.

The introduction of decoupling encourages farmers to stop the fattening activity. The "Milk + Young bull" farm completely removes this production and uses free area to produce cereals (see Table 2). The milk yield per cow increases to the maximum (9000 litters/year) to free up lands for cereals. The model arbitrates between the profitability of the feedlot and the cereal crops. This change of production allows a rise of the gross farm excess (+13%) and a decrease of working time (-40%) thus freeing permanently 1.2 AWU. Stopping the production of young bulls decreases nitrogen rejection (-53%).

Nevertheless, it is unlikely that this situation will happen for three main reasons:

i) Stopping fattening means not using an important part of buildings. 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.

ii) The conversion of fattening activity to crop production generates costs that are not taken into account by the model (investments in storage facilities). This feedlot activity was developed within the framework of a global reflection on the organization of work, on the use of equipment, and also on the financial balance of the farm and they cannot be easily challenged. However, it is difficult to say whether this strategy will continue beyond the period of depreciation of investments.

iii) Finally, we are in the case of a single producer who has no influence on prices: they are exogenous to the model and do not change with the decisions. The fattening activity is largely dependent on meat prices but many farmers realize this production under a contract with slaughterhouse. It is reasonable to assume that the industrial companies maintain this contracting policy to ensure sufficient production volumes and avoid significant price variations.

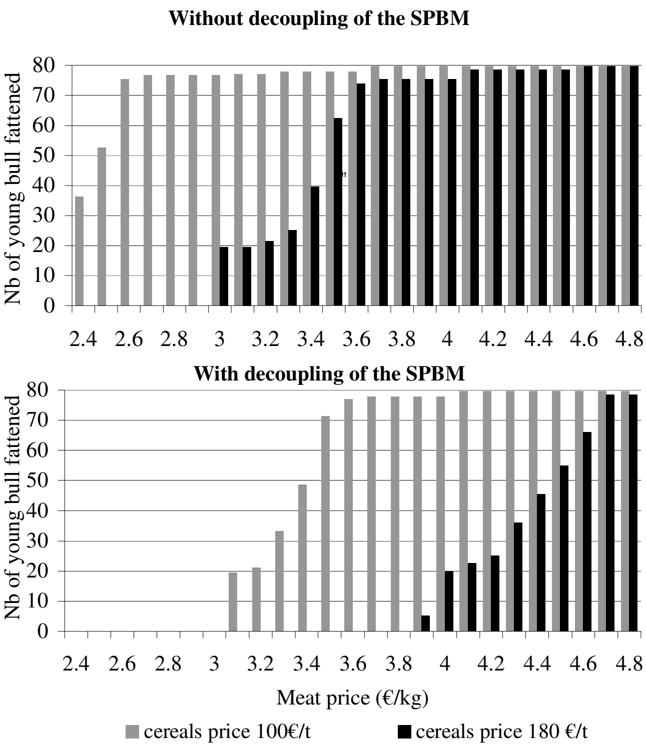

Fig. 2 Fattening of young bulls according to the meat price and cereals prices

The report of the Office de l'Elevage (2008) shows that in 2007 the number of young bull did not decreased in France.

The Fig. 2 shows that the importance of fattening activity is conditioned both by the meat and cereals price. Despite the increase in the price of meat in 2007, it is not enough to encourage farmers to resume the fattening activity. In this situation (2007 cereals price: 180 €/t), the price of meat should increase by 30% (3.9 €/kg) to encourage farmers starting to fatten bulls. Moreover cereals price rise affects the sale of grains, but also the concentrated food of which bulls are large consumers. We note that the full decoupling of the SPBM is strongly disadvantageous to this production: before the implementation of the reform each animal received a premium of 210 €. The price of meat has to increase by almost 1 €/kg to offset this effect. In other words, farmers do not lose money by continuing to fatten bulls, but they could earn more by replacing this production by cereals.

D. Regionalization of SPS: significant redistributions

We study the impact of the regionalization of the single payment on the dairy farmer's behaviour. France (such as Spain and Italy) chose to define the value of the SP on the farm's historical references. However, the Luxembourg Agreement provides an opportunity for Member States to implement the Single Payment Scheme at the regional level (EC Regulation No. 1782/2003 article 58 and 59). Regionalization allocates the same amount of direct aid per hectare to all farmers in a region. The global payment is then equal to the product of this amount for the eligible area of the farm. The text leaves some opportunities in the definition of a regional scale, with or without distinction between arable and grazing lands. Several Member States decided to apply the principle of regionalization such as England or Germany.

We compared the 2007 situation with the implementation of the CAP reform (at the high level of prices) to the regionalization of the single payment (without distinction between arable and grazing lands). The amount is allocated by administrative region and we consider that this award of the SP is accompanied by the full decoupling of subsidies (estimated thanks to the French FADN of 2003 in Chatellier, 2006). It is an important question because in the French dairy sector, the allocation of aid based on a historical reference economically promotes farms with an intensive production system. Farms using a system based on grass, often seen as more environmentally friendly, receive a lower amount of aid (for the same level of production). Moreover, the European Commission recommends that Member States apply the single payment scheme at the regional level.

Table 2. Implementation of the regionalization

	Grazier Farm		Semi-intensive Farm		Milk +cereals Farm		Milk +Young bull Farm	
	2007 (price increase)	Regionali-zation	2007 (price increase)	Regionali-zation	2007 (price increase)	Regionali-zation	2007 (price increase)	Regionali-zation
FGE (€)	61 800	66 200	61 000	58 000	148 600	144 500	142 400	116 800
Cereals (ha)	13.4	13.4	11.4	10.0	77.9	77.9	60.4	60.4
Corn silage (ha)	5.8	5.8	15.1	11.8	22.2	17.3	21.6	21.6
Grassland (ha)	57.8	57.8	20.6	25.2	25.7	30.7	10.0	10.0
Set-aside (ha)			2.9	2.9	11.2	11.2	8.0	8.0
Dairy cows (nb.)	51	51	46	46	57	51	45	45
Young bull (nb.)							0	0
Milk yield (l/year)	5 800	5 800	6 600	6 600	8 200	9 200	9 000	9 000
Total output (€)	154 500	160 600	147 100	143 100	324 300	315 200	292 900	280 000
Total subsidies (€)	22 600	28 700	22 300	18 300	58 000	49 600	49 200	36 300
Variable costs (€)	35 200	35 200	40 300	44 200	82 400	83 400	70 000	69 900

The simulation indicates an income transfer between farms: the Milk + Young bulls type of farming see its FGE decreases by 18% while that of the grazier farm increase by 7% (see Table 2). The extensive farms with large surfaces benefit from this transfer: they receive subsidies which originally were intended to beef-cattle farms and crop farms. However, the model shows a very little change in production. In the dairy sector, the rate of initial decoupling is high. Full decoupling encourages the grazier and cereal farmers to slightly increase their grassland area. Overall, the crop area, the number of animals, the milk yield per cow or the feeding system are very close to the baseline. When the subsidies are totally decoupled, the farmer chooses the more efficient productions, considering price and performance of each activity. The model left suggests that there is no relationship between the amount of aid given and the production system chosen. However the model does not take into account the investments. A farmer receiving a significant amount of aid can modernize his production equipment to make it more efficient and increase his income (either through an increase in the product or lower expense), or he may also expand his farm.

IV. CONCLUSION

The linear programming method at the farm level is suitable to analyse the impact of public policy on the dairy farmers' behaviour. This technique allows, with its precision, to place the technical, biological, structural, environmental and regulatory realities at the heart of the producer's choice. However, keep in mind the limitations of the method based on instantaneous adjustment of production factors, constant yields and the idea that the actors are primarily guided by the desire to maximize their income (while other considerations may play a more important role). Moreover, prices are not endogenous variables, the producer does not take his decisions in light of the evolution of the global supply.

This study has confirmed that the decoupling of supports to agriculture encourages dairy farmers to adopt a more extensive production system. All things being equal, and given the considered prices, the Luxembourg agreement also encourages farmers to stop fattening bulls. The increase in the price of agricultural raw materials has a positive impact on the economic results, but it does not change the situation for young bulls. This contributes to an increase in cereal surfaces. The CAP reform reaches its goal because it restores their role to prices as indicators of the market's situation. Farmers now take their decisions based on those prices.

It is important to note that the current situation prevailing in agricultural markets is unprecedented and changes the balance between the input and output. The effect of price changes on the strategies of producers must be considered with a particular attention. However, the organization of the dairy sector is not only composed of producers: dairy companies, whether private or cooperative, will play a very important role in organizing the dairy sector (concentration of processing units in areas with high densities dairy to reduce collection costs, contracting with the producers).

All of this is guided by the decisions of the Member States that are changing the CAP in accordance with the WTO negotiations and market trends. The CAP "health check", scheduled for 2008, will thus draw the contours of the future income support policy by addressing important issues for dairy farmers such as the phasing out of the milk quota which is already a subject of controversy. This last point leads to important questions for dairy producers. The model developed should help to investigate the farmers' behaviour and their productive capacity in the new situation.

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