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## **Assessing the 2003 CAP Reform Impacts on German Agriculture Using the Farm Group Model FARMIS**

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# Assessing the 2003 CAP Reform Impacts on German Agriculture Using the Farm Group Model FARMIS

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## *Abstract*

FARMIS is a comparative-static process-analytical programming model based on FADN data for the German agricultural sector. Recent developments cover the areas of the modelling of land, premia and quota markets, and the creation of a generic model design and structure which allow the use of different databases such as the EU FADN. The impact on the German agricultural sector of 2003 CAP Reform is analysed for both the Single Farm Payment (SFP) and the national implementation (Regional Model: RM). The analysis shows that the impacts of both decoupling schemes on factor allocation and corresponding supply are similar, but differ with respect to income effects. The rental prices of milk quota decrease in both scenarios. While land prices are predicted to decrease under the SFP, in the case of the RM rental prices for grassland increase significantly.

**Keywords:** Mid Term Review, decoupling, farm group model, FADN.

## *1. Introduction*

In many countries, models of the respective national agricultural sector exist and are successfully applied for policy analysis and policy advice (see, e.g., EAAE modelling seminar 2001). These models have often evolved considerably over time, gaining from experiences made in applications as well as from PhD studies. The detail of these models is therefore often high, not only with respect to national policy instruments and economic interrelations, but also concerning bio-physical and environmental processes and effects. However, while the interweavement of markets and the common framework of the EU agricultural policy often require an EU-wide analysis, the extensive data needs of these models generally have prevented an extension of these approaches to other countries. This holds true especially for farm level models. Against this background, the paper describes the stepwise broadening of a detailed national

farm level model to the EU, enabled by the use of the EU FADN and the involvement in several international research projects.

The paper will provide a short description of the national model FARMIS, focussing on recent developments in the areas of the modelling of land, premia and quota markets and refinements in the presentation of cattle production activities, which became necessary for an adequate modelling of the effects of the Luxembourg reform. Subsequently, the extension of the model to cover the EU is presented. An application of the national model to the Luxembourg decision on agricultural policy reform rounds off the paper.

## ***2. Model and data and recent developments***

### *2.1 Model structure and data*

FARMIS is a comparative-static process-analytical programming model based on FADN data, with individual farm data aggregated to farm groups. The core of FARMIS is a standard optimisation matrix which contains 27 main activities of crop and 15 activities of livestock production in the current version. The matrix restrictions cover the areas of feeding (energy and nutrient requirements, calibrated feed rations), intermediate use of young stock, fertiliser use (organic and mineral), labour (seasonally differentiated), crop rotations, and political instruments (e.g., set-aside, quotas). Key characteristics of FARMIS are (Jacobs, 1998; Osterburg et al., 2001; Bertelsmeier et al. 2003, Bertelsmeier, 2004):

- Improved aggregation factors that allow a representation of the sector's production and income indicators (Osterburg et al., 2001)
- Input/Output coefficients of all activities are consistent with information from farm accounts
- A positive mathematical programming procedure is used to calibrate the model to the observed base year levels

The national FADN includes the farm accounting data of about 11 000 farms with roughly 8 500 different variables, and is available from the financial year 1994/95 onwards. FARMIS uses farm groups rather than single farms to ensure confidentiality of individual farm data, but also to increase manageability and increase the robustness of the model system in face of data errors which may exist in individual cases. Homogenous farm groups are generated by the aggregation of single farm data. Standard stratification criteria for the establishment of farm groups are region (NUTS II), farm type (field crops, milk, grazing livestock, permanent crops, pigs and poultry, horticulture) and farm size (criteria for size depend on farm type, e.g., size of field crop farms refers to ha UAA). Generally, stratification of farm groups is flexible and can be adjusted depending on the specific policy to be analysed. The current stratification used for policy impacts analysis for Germany is based on 434 farm groups. For the generation of the

model, FADN-data from at least two consecutive years are used in order to enhance the stability and significance of the results. FARMIS is regularly used for policy advice to the German Federal Ministry of Consumer Protection, Food and Agriculture (e.g., Kleinhanss et al. 2004a, 2004b, Offermann et al. 2003).

Part of the information needed to define the coefficients for the activity-based optimisation matrix is directly available from the farm accounts, e.g., production levels, physical yields and corresponding output prices. Activity-specific input coefficients, however, generally need to be generated as the respective information in the farm accounts is aggregated. To this end, in the first step input coefficients like fertiliser, fodder, machinery are set based on a normative approach. Based on information from farm management handbooks, the use of input factors of each process is determined either in relation to yields (e.g., input of feed or fertiliser) or in relation to structural characteristics (e.g., use of machinery). In a second step, these normative input coefficients are adjusted according to corresponding monetary accounts in the accounting data of the respective farm group. This is trivial in cases of single inputs and corresponding farm accounting data, resulting in a simple correction factor. The consistency problem gets more complex when more coefficients have to be matched with a single account. It is especially complex if coefficients, which are used in the model, are in physical units, like fodder or fertiliser, and data provided in the farm account is of monetary nature.

*Example: Input-output coefficients for fertilizer.* Fertiliser coefficients reveal an example for such a rather complex estimation problem for consistent I/O coefficients. Based on the given value of yields, livestock number and mineral fertiliser expenses in total, the unknown fertiliser requirement of crops, the effective (plant usable) fertiliser supply in manure and the mineral fertiliser prices need to be established for each farm group. In FARMIS, a Generalised Cross Entropy formulation (Golan et al. 1996) is used for this estimation, which allows the inclusion of prior information about the unknown parameters. Support points for the parameters are centred around expectation values. The expected values are calculated based on farm account statistics and normative data, for example the expected value of fertiliser need of crops is calculated based on yield dependent fertiliser need functions. The spread of support points restricts the results to plausible values. Confidence in the supports can be reflected by placing almost all of the mass of the priors at the points nearest to the centre (Golan et al., p90) for relatively well trusted normatively estimated data like fertiliser prices, and spreading the mass more uniformly for parameters like nutrient availability in organic manure.

$$\begin{aligned} \text{MIN CE}(pO_{f,k}, pN_{f,k}, pP_{f,k}) &= \sum_{f,k} pO_{f,k} \cdot \ln\left(\frac{pO_{f,k}}{qO_{f,k}}\right) + \\ &\quad \sum_{f,k} pN_{f,k} \cdot \ln\left(\frac{pN_{f,k}}{qN_{f,k}}\right) + \sum_{f,k} pP_{f,k} \cdot \ln\left(\frac{pP_{f,k}}{qP_{f,k}}\right) \\ O_f &= \sum_k SO_{f,k} \cdot pO_{f,k} \quad \forall f \end{aligned}$$

$$N_f = \sum_k SN_{f,k} \cdot pN_{f,k} \quad \forall f$$

$$P_f = \sum_k SP_{f,k} \cdot pP_{f,k} \quad \forall f$$

$$\sum_k pO_{f,k} = 1 \quad \forall f$$

$$\sum_k pN_{f,k} = 1 \quad \forall f$$

$$\sum_k pP_{f,k} = 1 \quad \forall f$$

$$N_f = PUR_f + O_f \quad \forall f$$

$$\sum_f PUR_f \cdot P_f = FCOST$$

$k$  = index on support points

$f$  = index on fertilisers (nitrogen, phosphorus, potassium, lime)

$PUR_f$  = purchase of mineral fertilisers

$P_f$  = Prices of fertilisers

$N_f$  = fertiliser need of crops

$O_f$  = nutrients in organic manure

$FCOST$  = total expenditure for mineral fertilisers (as provided from farm account)

$SO_{f,k}, SN_{f,k}, SP_{f,k}$  = support points available nutrients in manure, fertiliser need of crops, fertiliser prices

$pO_{f,k}, pN_{f,k}, pP_{f,k}$  = posterior probabilities

$qO_{f,k}, qN_{f,k}, qP_{f,k}$  = a-priori probabilities

The relation of estimated and expected parameter values is then used to correct the normative values to get consistent prices and activity-specific I/O coefficients for fertiliser nutrients. A similar approach is applied for the estimation of feed rations consistent with livestock nutrient requirements, on-farm fodder growing and feed expenditures from the farm accounts.

A positive mathematical programming procedure is used to calibrate the model to the observed base year levels, with non-linear terms standardised to external elasticities. In the linear part of the objective function, farm income<sup>1</sup> minus (opportunity) costs for land and labour as well as the interest on borrowed capital is maximised.

The policy simulation process (ex ante analysis) proceeds in two steps. In the first step a reference scenario is established for a target year in the future, usually assuming that the present agricultural policy will continue. Furthermore, estimates on changes in general farm structure (i.e., distribution of farm size classes) and technical progress are used as external model inputs. This especially concerns the development of yields in crop and livestock production

<sup>1</sup> Farm income here refers to net value added. Costs of fixed factors have to be covered irrespective of whether they are owned by the farmer or not.

and monetary coefficients, e.g., input and output prices. The estimation of the future development of natural yields due to technical progress is based on a time series analysis which results in annual growth rates. The development of producer prices for agricultural products is often defined by the policy framework of the reference scenario and complemented by price forecasts of other models or experts' estimations.

In the second step, alternative policy measures are specified, e.g., through additional activities and restrictions or changes of matrix coefficients. The outcome of the optimisation can be compared to the result of the reference scenario and allows one to derive statements on the impacts of different policy measures. The definitions of reference and alternative policy scenarios as well as assumptions are harmonised with those used in other models of the FAL working group.

## 2.2 Modelling transfers of land and milk quota

In line with the current policy regimes in the dairy sector, an exchange of milk quota between farms via quota trade has been integrated in the model to improve the estimation of supply effects (Bertelsmeier 2004). The milk quota market is implemented as a rental market where farm groups act in defined trading zones. In Germany, these trading zones are generally based on the NUTS I level and in some cases on the NUTS II level. The marginal rate of return of milk production, compared to the quota price, is the decision criterion to lease in or to lease out milk quota. In the model, the existing equation restricting milk production  $Y_n^{milk}$  to own milk quota  $b_n^{milk}$  for each farm group was extended to allow quota leasing  $QUOTTRADE_n$  (Equation 1). The sum of the activities leasing in and leasing out must be in balance to ensure that the quota available in the trading zone is not exceeded (Equation 2).

$$Y_n^{milk} \leq b_n^{milk} + QUOTTRADE_n \quad \forall n \quad (1)$$

$$\sum_w QUOTTRADE_w = 0 \quad \left[ \pi_w^{quot} \right] \quad \text{for all trading regions} \quad (2)$$

$w$  = indices of farm groups in trading region

For the calibration step, the milk quota prices are exogenous and derived from the regional purchase prices for milk quota observed at the regional quota auctions in Germany. In the base year run of the calibrated non-linear model, the shadow prices of the balance restrictions then equal these quota prices.

In the projection part of the model, either a simultaneous or an iterative optimisation of the farm groups is used for modelling quota trade in the target year, depending on the number of farm groups that have to be optimised in a trading zone. The simultaneous optimisation used for small trading zones (NUTS II) allows direct competition of farm groups for available quota in a defined region. The equilibrium price equals the shadow price  $\pi_w^{quot}$  of the regional

balance restriction (see equation 2). For computational reasons, the iterative procedure is used when trading regions are large. Following the underlying algorithm, after each iteration an adjustment of the quota price is made depending on the ratio of used quota to total regional quota, until milk production equals the regional quota (unless the quota price is zero if the quota is not fully utilised).

The transfer of land in a leasing market, differentiated between grassland and arable land, as well as the transfer of premia entitlements were implemented into the model in an analogous manner (Bertelsmeier 2004). Farm groups compete simultaneously for the respective resources in a production region based on NUTS II level. Therefore, in the model the land restriction was extended and an equation to balance the regional trade of land is introduced (Equation 3). The total of all leasing activities  $LAND_{ml}$  must equal zero in a region and the corresponding shadow prices  $\pi_{ml}^{land}$  are interpreted as regional rental prices. Rental prices are calibrated to the observed factor prices of the base year.

$$\sum_m LAND_{ml} = 0 \quad \pi_{ml}^{land} \quad \text{for all land types and for all farm groups} \quad (3)$$

$m$  = Indices farm groups;  $l$  = indices of land type (grassland or arable land)

Clearly, land trade in FARMIS is a stylised and very simplified way of modelling the land market, based on the changes of the marginal rate of return of land (grassland and arable land) under different policy options. Further extensions to account for different soil qualities and the farm-field distances can improve the modelling, but it should be acknowledged that the land market is very complex and not all aspects can be implemented in this type of model.

### 2.3 Cattle activities

The Luxembourg agreement and the recent CAP reform of the dairy sector will have significant implications for cattle production. To be able to model the respective changes in production in detail, the livestock matrix is currently extended to better represent male and female cattle of different age groups by type of use and breed (i.e., dairy cows including descendants and suckler cows including descendants). Based on the accounts in the FADN database, 14 activities of cattle production are distinguished (milk production, suckler cows, old cow fattening, raising or fattening of young dairy and beef cattle in different age classes, bull fattening in different intensities and breeds). As the FADN accounts do not differentiate between breeds (beef breed or dairy breed) and sex (male and female) for all age classes, an algorithm is developed to separate and map the cattle accounts to each activity.

### 2.4 Extension to other databases

Another enhancement of the FARMIS modelling system is to work with other databases, namely the EU FADN. The basic concept for this exercise is to have a generic model, irrespec-



tive of the database used, based on common definitions of sets, variables and parameters. The main interface comprises a database specific programme, translating the raw data to basic model input data. However, optional interfaces also exist at different later stages of the modelling system, allowing database specific modelling if desired by the user (Figure 1). The close similarity of the database of the original model, the German FADN, and the EU FADN, is facilitating a stepwise broadening of the detailed national farm level model to the EU.

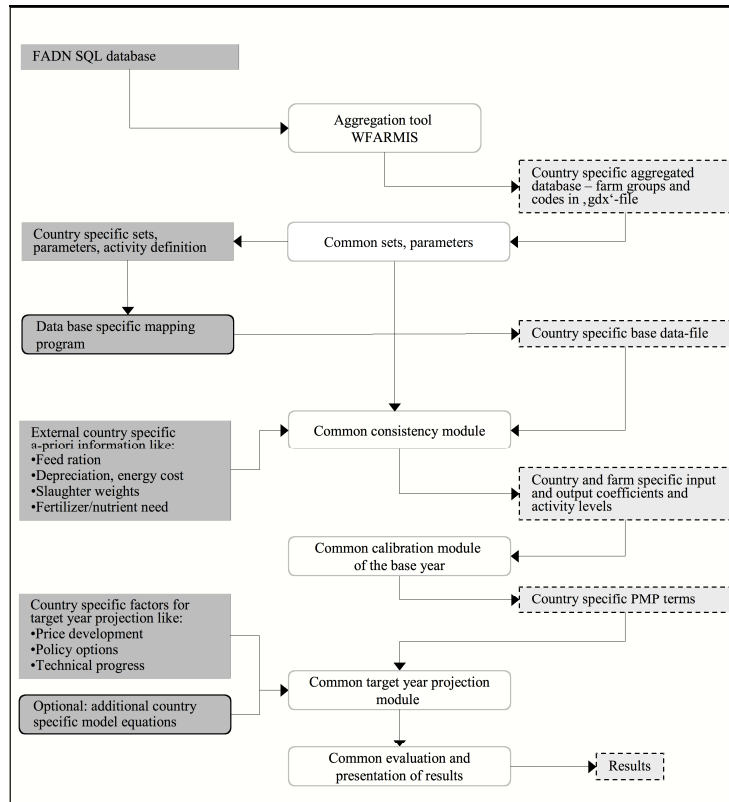


Figure 1. Structure of an extended FARMIS allowing use of different data bases

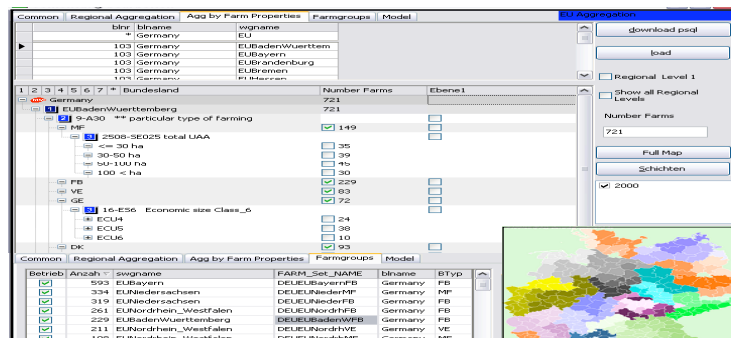
Calculation routines and external (a-priori) information from the German model can be adapted and used for other countries until better information becomes available, as is currently the case as a consequence of the involvement in international research projects like GENEDEC and EDIM and the close co-operation with partners from other EU member states. To this end, standardised data sheets (MS EXCEL) have been developed to enable pro-

ject partners to provide country-specific a-priori information on input or output coefficients not available from common sources. Typical sources for these data are farm management manuals or expert assessments' (e.g., by farm advisors).

### 2.5 Technical implementation

In order to ensure a convenient data handling, the German FADN data as well as the EU FADN, data were structured and organized within a relational SQL Database, which serves as main source for the farm model. Additional data such as regional vectors or sectoral information were added to the SQL structure to be consistent with the farm group structure. A server is utilised for the database, which guarantees fast and secure data exchange. To meet the challenge of extending the FARMIS model toward the EU an aggregation program was developed to group farms and generate "include files" for the model, which is completely written in the programming language GAMS. The Aggregation tool (Gocht 2004) is a Windows styled program (Figure 2), which enables the user to produce farm groups and export the weighted datasets into a GDX File or alternately into text files, which then can be loaded into the GAMS Modelling System. To improve the quality of the aggregation, the program can handle multiple years and identify identical farms. If more than one year is used, weighting factors for each farm group are adjusted to the decreasing population in the FADN database. For the future it is also intended to store the results of the modelling runs in the database for use in further analysis and to organize the huge amount of data which will be generated during different runs.

Figure 2. Screen shots of farm stratification and aggregation program



### *3. Analysis of MTR impacts in Germany*

Member States of the EU were given several options for the implementation of the Luxembourg Agreement. FARMIS was used to assess the impacts of these policy options. As the modelling work for the EU version of FARMIS was not yet completed, the existing national version of FARMIS was used. The analysis focuses on the impacts on supply, income and income distribution, and the rental prices for land and quota.

#### *3.1 Scenarios*

For the analysis two scenarios, based on the Single Farm Payment (SFP) and the Regional Model, were chosen, and their results compared to the continuation of the Agenda 2000, taken as the Reference.

The scenarios are similar in that direct payments are fully decoupled, but they differ in the way this is implemented. To assure comparability, both scenarios and reference were determined with regard to the target year 2012. Price responses to the modelled impacts on quantities were estimated using GAPsi, a partial equilibrium model developed and maintained by the Institute of Market Analysis and Agricultural Trade Policy of the FAL. Price changes for milk, beef and calves were modified based on expert judgements of the Federal Ministry of Consumer Protection, Food and Agriculture. Compared to price developments of the reference, mainly the following price changes were assumed:

- A drop of the price for rye due to abolishment of rye intervention
- A further decrease of the price for milk due to lowered intervention prices
- An increase of the price for beef by 10 %
- A decrease of the prices for calves and young cattle

Further specifications and assumptions of the scenarios are given in the following:

#### *Reference: Agenda 2000*

The reference scenario represents the situation in the year 2012 that would have been realised if no changes had been made to the Agenda 2000 package. Compared to the base year 1999, all important elements of the reform like price reductions for milk, beef and cereals, adjustment of direct payments and the milk quota extension were implemented.

#### *Scenario 1: Single Farm Payment (SFP)*

The first scenario orientates itself at the standard model of the Luxembourg Agreement: Direct payments are fully decoupled and farmers receive a Single Farm Payment based on the reference area and the number heads of eligible animals in the base period. To receive payments land has to be kept in good agricultural condition.

*Scenario 2: Regional Model*

The second scenario represents the German implementation of the Luxembourg Agreement in the target year. In Germany the Regional Model will be introduced stepwise, and 14 regions with different payment levels are distinguished. In the beginning, total farm entitlements consist of a combination of farm individual single payments and area based entitlements for grassland and arable land. During a transition period, payments for grassland and arable land are harmonised and the share of farm individual payments of total entitlements is stepwise reduced. The scenario used in FARMIS is based on the regulations valid in the final stage of the Regional Model and therefore represents a pure regional model.

*3.2 Impacts on land use and production*

The analysis demonstrates that both the SFP and the Regional Model have a notable impact on land use and production. Table 1 shows the relative changes at sector and regional level in comparison to the reference. Looking at the results it becomes apparent that the scenarios do not differ much regarding the impact on **land use** and production. Exemptions are the impacts on the amount of fallow arable land and grassland. In these cases the SFP and the Regional Model do deviate. The other changes are mainly induced by the price reduction of rye, decoupling and criteria and size of eligible areas. The main predictions of the model were:

- Reduction of the total acreage of cereals. The area use for cereal production will decrease by 8 to 10 %, caused by lower rye production and the increase of set-aside and land abandonment in less favoured areas. Due to better natural conditions the reduction in the western part of Germany (4-7 %) is lower than in the eastern part (12-4 %).
- Decrease of the acreage of protein crops. The area of protein crops will decrease by around 10 % despite the production incentive due to a coupled premia of 56 €/ha.
- Impact on oilseeds. Food and non-food oilseeds will be affected differently. The area of food oilseeds will decrease by 6 to 8 %, while the area of non-food oilseeds will increase by 27 %. Compared to the reference where non-food is produced on set aside areas, under MTR conditions production will take place on land without set-aside obligations and therefore partially substitute food oilseeds. This is mainly caused by rather similar prices for food and non-food seeds and the production incentive of 45 €/ha for energy crops on non set-aside areas.
- Increase of potatoes and sugar beet acreage. Potato and sugar beet areas are increased by a small degree. In the case of sugar this is caused by a decrease of the intensity of production. The level of production is unaffected because of quota restrictions.
- Decrease of the acreage of silage maize. The area of silage maize will decrease by 8 % in the SFP scenario, but only by 6 % in the case of the Regional Model. Due to decoupling silage maize production will lose its competitive advantage compared to other arable fodder crops, which were not subsidised under the conditions of the former premia regime. The amount of land used for production of other types of ar-

able fodder plants will increase by about a quarter, but lower intensity levels will be realised.

- Increase of grassland use. Despite the reduction of beef production, the grassland use will increase by 1.5 % in the case of the Regional Model. This is mainly caused by the use of formerly unused grassland which will be reactivated to access additional payments.
- Impact on the amount of fallow land and set aside. The area of set aside and fallow land differs between both schemes. While the total of obligatory set-aside does not change at all, set-aside areas for non-food production decrease by three quarters under the terms of the SFP and will disappear completely under the conditions of the Regional Model. The remaining set-aside area, not used for production, will increase by 48 and 65 % respectively. In the case of the SFP about 2 % of arable land will fall idle. This happens mainly on sandy soil regions in eastern Germany. In the case of the Regional Model the amount of fallow grassland and fallow arable land will be reduced to almost zero compared to the SFP. The area will be managed according to the minimal standards required for the activation of entitlements.

## 6. Modelling Decoupling at National and EU Level

**Table 1.** Change of livestock production, land use and income

Scenario		Sector			North		Centre		South		East
		Reference <sup>1)</sup>	SFP <sup>2)</sup>	RegMod <sup>3)</sup>	SFP	RegMod	SFP	RegMod	SFP	RegMod	SFP
<b>Livestock production / land use</b>											
Fattening bulls	Tsd. heads	2217	-26	-26	-26	-25	-36	-35	-21	-21	-39
Suckler cows	Tsd. heads	460	-30	-28	-36	-41	-36	-38	-28	-27	-25
Cereals	Tsd. ha	6504	-10	-8	-6	-4	-6	-5	-7	-7	-14
... Rye	Tsd. ha	762	-23	-21	-20	-16	-18	-18	-22	-20	-25
Protein crops	Tsd. ha	235	-13	-11	-6	-3	-5	-4	-8	-7	-15
Oilseeds	Tsd. ha	1323	-6	2	-2	-1	1	1	-3	-3	2
... Food	Tsd. ha	1008	-8	-6	-3	0	-1	-1	-6	-5	-11
... non-Food	Tsd. ha	315	27	27	4	-7	11	12	11	4	34
Set-aside	Tsd. ha	811	0	1	-3	16	17	28	22	50	118
... With non-food production	Tsd. ha	315	-75	-100	-4	-100	-62	-100	-37	-100	-93
... Without non-food	Tsd. ha	496	48	65	-3	16	17	28	22	50	118
Maize for silage	Tsd. ha	1019	-8	-5	-5	-2	-20	-4	-9	-6	-8
Other arable fodder crops	Tsd. ha	784	29	26	26	27	36	36	33	29	26
Sugar beets	Tsd. ha	410	4	4	3	4	4	4	4	4	5
Potatoes	Tsd. ha	282	3	5	3	5	3	3	3	4	1
Permanent grassland	Tsd. ha	4275	0	2	-1	0	-2	0	-1	1	2
Agric. used land (UAA)	Tsd. ha	15653	-2	0	-2	0	-2	0	-1	0	-1
		abs	abs	abs	abs	abs	abs	abs	abs	abs	abs
Grassland fallow	Tsd. ha	101	116	36	8	0	7	0	40	15	60
Fallow of arable land	Tsd. ha	0	220	5	94	0	17	0	28	0	80
<b>Production</b>											
		abs	%	%	%	%	%	%	%	%	%
Milk	1000 t	29104	0	0	0	0	0	0	0	0	0
Beef meat	1000 t	1092	-15	-15	-18	-18	-19	-18	-11	-11	-15
Pig meat	1000 t	4681	1	1	0	0	1	1	1	1	1
<b>Income</b>											
Direct payments	Mio. EUR	4795	5	3	4	-1	4	7	11	7	2
NVAf <sup>4)</sup>	Mio. EUR	7868	-1	-3	-1	-4	-1	0	2	-1	-5
Net-income	Mio. EUR	5086	20	-12	24	-15	32	-8	22	-10	10
Costs of land rented	Mio. EUR	1634	-67	25	-64	24	-76	17	-80	36	-60
Rental price of arable land	EUR/ha	185	-73	3	-77	-3	-77	-5	-82	5	-62
Rental price of grassland	EUR/ha	56	-11	232	0	164	-63	294	-62	349	331

1) Projection of Agenda 2000 towards 2012. 2) Single Farm Payment. 3) German Implementation of decoupling (regional model). 4) Net valued at factor costs.  
Source: FARMIS 2004.

**Milk production** will not be affected by the reform under assumed price changes. Some of the farm groups do not fulfil their quota, but their quota will be transferred to other farms within the regions defined in the German scheme for quota trade.

The strongest adjustments are predicted for **beef production**, although no specific price-policy measures were introduced. Bull fattening and suckler cow husbandry, previously favoured by high production-related premiums, will be reduced in the case of both de-coupling schemes. Bull fattening will be reduced by 26 % on average, whereby the adjustments in the North and South will be lower. The number of suckler cows will go down by 28 to 30 %, whereby the adjustments in the North and the Centre are substantially more pronounced than in the other regions<sup>2</sup>. Beef production will be stabilised by the constant supply of cow meat as well as the expansion of heifer fattening. Therefore the reduction of total beef supply (−1.5 %) is less pronounced than the reduction of bull meat production. The adjustment reactions occur despite the assumption of a rather favourable development of beef prices.

The results are rather sensitive to levels and relations of beef and calf prices. Changes of suckler cow production might be overestimated, because some federal states are planning to introduce specific measures within agri-environmental programs or Pillar-II (less favoured area allowance) favouring land-dependent livestock systems.

Other branches of meat and poultry production will be not much affected by the reform, because feed prices will not change at all due to rather constant prices for energy and protein feed.

It can be concluded that the scope and allocation of production will be significantly affected by de-coupling, but the type of de-coupling, either the SFP or the Regional Model, will not induce significantly different allocation effects.

### *3.3 Income effects*

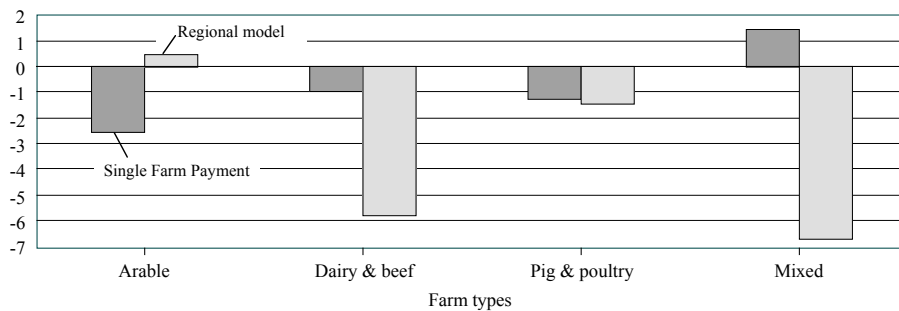
Despite the similar effects on production and allocation, the analysis shows that the schemes will differ in regard to their impact on incomes. In the final stage of the Regional Model, the whole premium volume will be transferred into equal but regionally differentiated levels of entitlements for agriculturally used land (excluding permanent crops). Entitlements will also be given to activities formerly excluded from premia schemes (i.e., vegetables, food potatoes, sugar beets) causing some distribution effects. Furthermore, using the entitlement levels proposed by the Federal Ministry of Consumer Protection, Food and Agriculture, the total of direct payments in the Regional Model will be about 2 % lower than in the SFP.

The overall policy changes of MTR decisions were found to cause slightly negative income effects. Using net-value added at factor costs (NVAf) as an income indicator, income at the sector level will decrease by 1.3 and 2.8 % for the SFP and the Regional Model, respectively.

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<sup>2</sup> If agri-environmental measures with a minimum cattle density are applied, suckler cow holding could be stabilised (agri-environmental measures are not specified in the model). The compensatory allowance for less favoured areas, considered in the model as area premium, has no obvious effect on suckler cow production.

These results were caused by the milk market reform and the assumption that funds lost to the farmers due to modulation are not accessed again via environmental- or other Pillar II measures. As mentioned earlier, the Regional Model will induce a rather strong redistribution of direct payments. The redistribution can only be identified by looking at a disaggregated level, i.e., **by farm types**, size, intensity, etc. Income effects by **farm types** are shown in Figure 3. In the SFP scenario, dairy & beef farms get 12.7 % higher direct payments due to increasing milk premia. In the Regional Model, the redistribution of premiums from beef and dairy production towards land causes the increase of premia to be much lower (5.8 %). The model predicts income losses for beef and dairy farms to be 0.9 % in the SFP scenario and 5.7 % in the case of the Regional Model. Rather significantly different income effects can also be expected for mixed farms with 1.4 % and -6.7 % for the SFP and the Regional Model, respectively. Pig & poultry farms are not affected differently. In the SFP scenario, incomes of arable farms decline while they increase by 0.4 % in the case of the Regional Model. This difference is caused by the redistribution of premiums to land in the Regional Model. Farms producing sugar beets benefit especially because they did not receive area payments for land grown with sugar beets in the past.

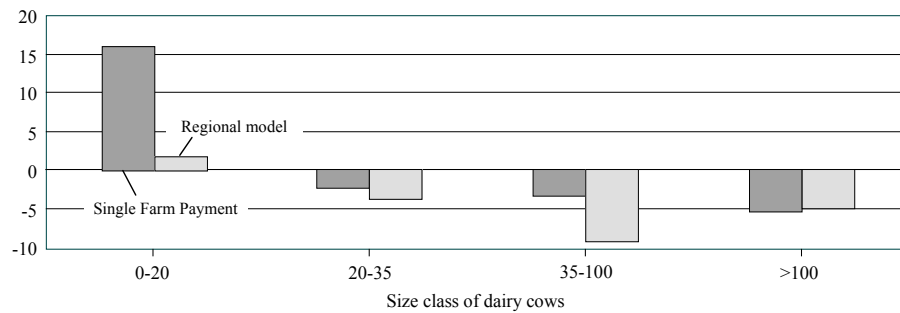


Source: FARMIS 2004.

**Figure 3.** Income effects (NVAf) by farm types

Dairy and beef farms are further differentiated according to their dairy cow herd size (see Figure 4). Farms with up to 20 dairy cows can expect a significant increase of income (16.1 %) under the conditions of the SFP scheme. This is mainly caused by higher beef prices, reduction of the activity level of beef fattening and a rather constant reception of direct payments derived from former beef activities. The premium redistribution caused by the Regional Model reduces this gain to 1.7 %. Farms with 20-35 dairy cows will have income losses of 3.6 % in the case of the Regional Model, but 2.2 % in the case of the SFP. Farms with 35-100 dairy cows are affected the most in the Regional Model scenario, because income changes are -9.1 % compared to -3.1 % under the conditions of the SFP. For larger sized farms income effects are in the range of -5 % for both decoupling schemes.





Source: FARMIS 2004.

**Figure 4.** Income effects in farms with dairy cows

The regional harmonisation of area payments in the German scheme also induces differing income effects at the regional level (see Table 1). Especially in the North and South, but in the East as well, the income is negatively effected by the Regional Model in comparison to the SFP. The Centre is positively affected by the premium redistribution and has slightly positive income effects compared to income losses of 0.8 % caused by the SFP.

#### *3.4 Income effects taking changes of rental prices for land into account*

The above used income indicator does not include changes of rental prices for land and quota. The inclusion of regional markets for milk quota, arable land and grassland via simulation of transfers between farm groups enabled the modelling framework to quantify changes of equilibrium prices caused by changes of economic conditions, i.e., the decoupling of direct payments. In the following the net-income is used as an additional income indicator. It is derived from NVAf by subtracting costs for hired labour and rents for milk quota and land. For the latter, the whole part of rented arable land and grassland is valued by the calculated equilibrium rental prices. Concerning transfers of entitlements in both decoupling scenarios, it was assumed that they are always related to eligible land.

Changes of rental prices **milk quota** due to decoupling of the milk premiums were found to be in the range of 3 to 4 ct /kg or about half of the rental prices in the Agenda 2000 scenario. They do not deviate much between the two decoupled premia schemes and are mainly determined by reductions of milk prices.

It was found that the impact of the decoupling schemes on the rental price differs by a huge degree. Decoupling via the SFP would induce a significant reduction of **rental prices for land** (Table 1). Those for arable and grassland would decrease by 73 % and 11 %, respectively. This is mainly influenced by two facts: the different level of entitlements of farm groups within regions and the existence of land free of entitlements but eligible for entitlements (about 5 %

of total area). Under these conditions, not land but entitlements are the restricting factor to receiving direct payments, because farmers can lease-out land without losing entitlements. Therefore, the rental price for land is oriented towards the ground-rent of land excluding direct payments. Rental costs for land decrease by two thirds and net-income increases by 19.8 % at the sector level.

In the case of the Regional Model, the number of entitlements is equal to the amount of land and therefore land free of entitlements is absent. This causes rental prices for land to increase by 3 % for arable land, but by more than 100 % for grassland. As a consequence, rental costs increase by one quarter and net-income falls by 12 % at sector level. This indicates transmission effects of direct payments in favour of land owners. As about 90 % of rented land belongs to owners engaged in non-agricultural sectors (Deutscher Bauernverband, 2004), the Regional Model induces further income flows from agriculture towards other sectors.

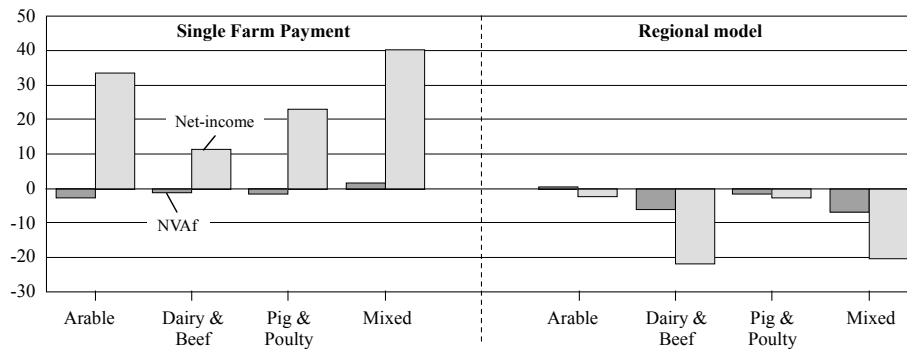
Effects on net-income differ significantly by the farm types shown in Figure 5:

- Arable farms profit from the large reduction of rental prices for arable land in the SFP scenario. Their net-income is increased by one third. As the Regional Model induces a slight increase of rental prices for arable land only, changes of net-income will be only -1.9 % and therefore be in the same magnitude as the effects on NVAf. Income effects of pig & poultry farms do not differ much from the impact on arable farms.
- In the case of the SFP, dairy and beef farms benefit from an increase of net-income by 11 %. In contrast, the Regional Model causes net-income to diminish by 21.6 % due to the increase of rental prices especially for grassland. Mixed farms are effected in a similar way.

It is concluded that farms with dairy or beef production suffer significant income losses under the conditions of the Regional Model caused by the transformation of premiums into unified entitlements for agricultural land. These are induced by:

- the redistribution of premiums from livestock in favour of land;
- and the increase of rental values, especially for grassland, caused by the lack of entitlement free land and regionally equalised entitlement levels.

One policy goal of decoupling was to reduce transmission effects of direct support and therefore improve the situation of active farmers. The analysis showed that with the Regional Model, the rise in rental prices will compromise this objective in countries with a high share of rented land (in Germany, about 60 % of agricultural land is rented). However, even the implementation of the SFP may only temporarily postpone this development, as the excess land free of entitlements, but eligible for payments, would soon diminish due the ongoing conversion of agricultural land to land used for settlement, industries and infrastructure in Germany.



Source: FARMIS 2004.

**Figure 5.** Income effects including changes of rental prices

#### 4. Summary and conclusions

FARMIS is a comparative static process analytical programming model based on FADN data aggregated to farm groups. There are 27 main activities of crop production and 15 activities of livestock distinguished. Input and output coefficients for the activities are consistent with information from farm accounts. A positive mathematical programming approach is used to calibrate the model to activity levels observed in the base year. Recent model developments cover the areas of land and milk quota markets. To better model expected impacts of the CAP reform on the dairy and beef sectors, the livestock matrix, mainly cattle production activities, is currently extended. Efforts are ongoing to develop FARMIS towards a generic model using different databases and embedded in a modern software environment, like an SQL database, including a flexible aggregation tool and an improved model structure written completely in GAMS. The model will be further developed and applied within two EU funded research projects in co-operation with partners from other EU member states.

The national version of FARMIS is used to assess the impact of 2003 CAP reform on the German agricultural sector. Two decoupling schemes are analysed: the Single Farm Payment (SFP) and the national implementation (Regional Model: RM). Regarding the impact on land use and supply, significant changes are predicted for arable crops (decrease of rye acreage, partial substitution of forage maize by other arable fodder crops and increase of set-aside) and beef production (reduction of suckler cow- and bull husbandry). However, the analysis showed that the impacts of both decoupling schemes on factor allocation and corresponding supply are similar. Both decoupling schemes differ when it comes to the impact on income. While at the sector level income effects of the two schemes are almost identical, in the case of the RM

the income of beef and dairy farms is significantly reduced compared to the SFP. These impact differences are caused by a re-distribution of direct-payments induced by the RM. Regarding the price development of agricultural assets, two main effects were predicted: First a reduction of the rental value of milk quota and secondly an increase of the rental value of land in the case of the RM. The reduction of the rental value of milk quota is mainly induced by price policy measures and decoupling, but not by the type of decoupling. The development of the rental values for land is influenced by the type of decoupling. While land prices are predicted to decrease under the SFP, in the case of the RM rental values for arable land do not change at all, and rental prices for grassland increase drastically. These results are in line with studies by Burrell (2003) and Gohin (2004).

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