Impact of CAP reform on agricultural production in the German federal state Baden-Württemberg: Scenario calculations with the regional model ACRE

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Abstract— **ACRE is an Agro-eConomic model for agricultural pRoduction at rEgional level. Based on an extension of Positive Mathematical Programming (PMP) this model was developed as a decision tool for politics with respect to questions of global change- and political scenarios. ACRE was applied in two interdisciplinary projects for simulation of agricultural production in two German river basins. Currently, the model was extended to calculate agricultural production for the federal state Baden-Württemberg in South West Germany. This paper introduces the results of CAP scenario calculations with the regional model ACRE for Baden-Württemberg.**

Keywords— **Regional model, agricultural production, CAP reform scenario.**

I. INTRODUCTION

In the past 20 years the relevance of modelling agricultural production at regional scale has grown. Including ecological and economic aspects, regional models have been developed as decision tools for agro-environmental questions [1] and are applied as instruments for supporting political decisions. For this issue, agricultural models require extensive data on farmers' production decisions with the possibility to simulate scenarios of global, climatic, political or economical changes.

The initial version of ACRE was developed in the framework of the interdisciplinary modelling project GLOWA-Danube [2]. This project aims at development of a water management model for the Upper Danube catchment area including parts of Germany (Bavaria, Baden-Württemberg) and Austria [3].

ACRE was extended and successfully applied in the interdisciplinary project RIVERTWIN-Neckar and simulated agricultural production of the Neckar river basin, which lies in the German federal state Baden-Württemberg. Currently, ACRE has been enlarged to the complete federal state Baden-Württemberg in order to provide information for this administrative area.

This paper presents the results of CAP (Common Agricultural Policy) scenario calculations with ACRE for the region Baden-Württemberg.

II. THE MODEL ACRE

A. Model approach

The Linear Programming (LP) method used traditionally for agricultural production modelling was replaced recently by the Positive Mathematical Programming (PMP) method. Extended versions of PMP make it possible to develop regional models with respect to specific questions of politics and production in agriculture.

ACRE is based on the method of Positive Mathematical Programming (PMP). PMP is an optimisation approach that maximises an objective value of a total gross margin function.

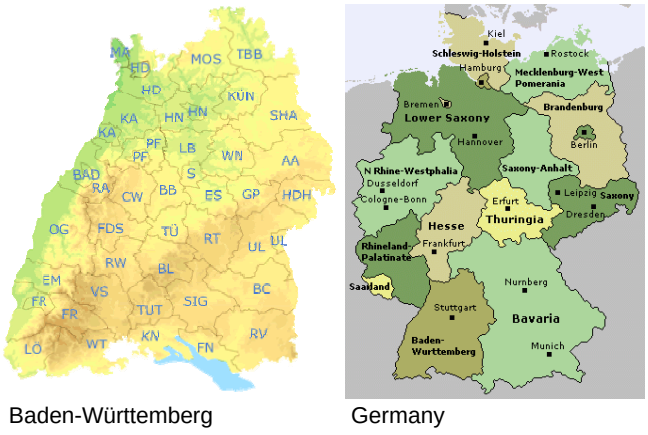
ACRE is a comparative static partial-equilibrium model, which optimizes the total gross margin on regional level by computing optimal production.

Agricultural production in each of the model's sub regions (on district-level) is represented by one single farm ('regional farm approach'), which is a district of NUTS3 level. For these administrative units the statistical production data are of a good quality and allow a sufficiently exact calibration of the model. We calibrated ACRE by the statistical data of the year 1999. Smaller districts, i.e. 'Stadtkreise', were aggregated to larger, by which they are encircled [2]. This aggregation makes the districts comparable with respect to the size of agricultural area.

The simulated time is one year. Agricultural production includes 23 food and non food crops, as

well as 12 production processes for livestock. Consisting of a process analytical approach, feeding of animals and fertilization of crops are optimized by using feed and manure produced model-endogenously. Trade between the districts is not possible. By variation of model parameters scenarios can be simulated. To simulate changes of CAP and markets subsidies and prices can be varied.

B. Model region



Baden-Württemberg Germany

Fig. 1 Map of Baden-Württemberg (South-West Germany) with NUTS3 districts and Germany. Source: [6], [7]

Of the complete area (3.58 Mio. ha) of Baden-Württemberg 1.65 Mio. hectares are used for agricultural production, which are nearly the half (46%) of the total area. Out of this utilized agricultural area (UAA) 51% are arable land, 34% are permanent grassland; 6% are used for production of permanent crops as fruit and wine and 9% is forest [4]. Due to different regional climatic and geographic conditions the agricultural production in Baden-Württemberg is regionally quite heterogeneous [5].

Depending on the natural and climatic conditions the NUTS3 districts vary from districts dominated by arable crop production to districts with high shares of permanent grassland. Districts with high shares of arable production are of climatic good conditions and have fertile soils, such as can be found in the regions of Heilbronn-Franken, Mittlerer Oberrhein and Rhein-Neckar-Odenwald in the North West of the regions. Districts with high share of arable area are for example Main-Tauber-Kreis (TBB) and Schwäbisch Hall (SHA) in the North East, see Fig. 1. Districts with high shares of permanent grassland are found in the regions Oberschwaben, Südschwarzwald and Schwäbische Alb (e.g. in the districts Ravensburg (RV), Biberach (BC) in the South East of the region). High shares of permanent crop area can be found in districts with climatic conditions allow the production of fruit and vine such as the districts Breisgau-Hochschwarzwald (FR), Bodenseekreis (FN) (in the South near the Lake of Constance) [5].

III. RESULTS OF CAP-SCENARIO CALCULATION FOR BADEN-WÜRTTEMBERG

A. Development of agricultural production and agricultural income

The effects of the CAP 2003 reform are simulated for the model region Baden-Württemberg up to the scenario year 2015.

Subsidies are assumed to be fully decoupled. Prices of the year 2007 represent increased prices for agricultural commodities. The obligatory set aside is assumed to be abolished. Increases of crop yields by technological progress are assumed according to historical regional yield increases.

Table 2 presents the development of selected indicators. The development of agricultural income is represented by the change of total gross margin (TGM), while the change of nitrogen input represents the environmental pressure from agricultural production. The basis for the percentage development (100%) is the status of the indicators in the reference situation in the year 2000 under Agenda 2000.

The change of agricultural land use is represented by the development of percentage share of total utilised agricultural area (UAA) in comparison to the reference situation under Agenda 2000. The unit for agricultural land use is percent of UAA (% of UAA); the unit for and the percentage difference between reference situation and CAP scenario of utilised agricultural area (UAA) is percentage points (pp).

Agricultural income is expected to increase by 11% in comparison to the reference situation. This increase can be explained by increased yields and prices and the decoupled subsidies, which are paid also for grassland areas. In the reference situation under Agenda 2000, the districts receive payments only for

environmental programs for the grassland. In CAP reform scenario the payments for grassland are increased by the unified regional payments for utilized agricultural area (UAA) (i.e. grassland (GL) and arable land (AL) under agricultural production). The reduction of subsidies for intensive crop production (e.g. for silage maize, and rape seed), and the cancellation of subsidies for fattening bulls is compensated by increased crop yields and prices.

The combination of reduction of livestock, the increase of crop yields and the changes in crop production provoked a slight increase of nitrogen (N) input by 5%.

Cereals as the most extended crop with 37% of UAA show no change. This effect results from the combination of increased cereals area in NUTS3 districts, which were specialized in cash crop production, and decreases of cereals area in NUTS3 districts which were dominated by grassland farming. Thus, the area of cereals seems to be unchanged in the complete model region.

Fodder crops show only a slight decrease. Other crops (e.g. oilseeds, root crops) decrease with -4pp of UAA. However, because of their small share of UAA, these crops are of regionally small importance. Marginal arable land is converted into extensive grassland by 4pp of UAA. The share of intensive grassland decreases slightly by 1pp of UAA.

Table 2 Development of total gross margin, nitrogen input and land use. Source: ACRE calculations.

Indicator	CAP scenario	Development
	% of reference [a]	%
Total gross margin	111	+11
Nitrogen input	105	+5
	% of UAA [b]	pp of UAA [c]
Cereals area	37	±0
Fodder crops area	8	-1
Others	7	-4
Intensive grassland	13	-1
Extensive grassland	31	+5
Converted arable land into grassland	4	+4

a) %: percent, reference reference situation. b) UAA: utilised agricultural area. c) pp of UAA: percentage points of UAA.

B. Regional development of agricultural total gross margin

In Figure 2 the relation between the share of grassland (GL) of utilised agricultural area (UAA) and the percentage development of total gross margin (TGM) is illustrated. In REF under Agenda 2000 premiums are coupled to crop production and animals while in 2015 the premiums are paid on the basis of a regional amount equal for grassland, arable land and fallow land.

Figure 2 illustrates that the development of TGM tends to increase for all districts and ranges from +5% to +20%. Districts with a share of grassland smaller than 40% of UAA show a higher variance, than districts with a grassland share of more than 50% of UAA.

The smaller increase of TGM in districts with a high share of arable land can be explained by the deletion of coupled premiums. Instead of former high premium for arable crops (e.g. rapeseed with 499 EUR per ha) or animals (e.g. bulls with 210 EUR per animal) these districts receive in CAP reform scenario the uniform amount of 302 EUR per hectare farmland. This reduces the TGM for arable land dominated districts significantly. However, the losses are compensated by increased yields and prices.

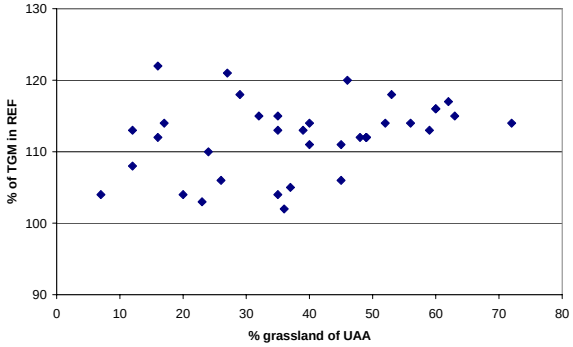


Fig. 2 Relation between the development of total gross margin (TGM) in % of TGM in reference situation (REF) and the share of grassland of utilized agricultural area (UAA). The diamonds represent the NUTS3 district. Source: ACRE calculations

Districts with more than 40% of grassland on the UAA tend to increase their TGM between 10% and 20%. Significantly higher subsidies for grassland area increase the TGM in grassland districts in comparison

to the reference situation (REF). Grassland districts received in reference situation 30 to 50 EUR ha^{-1} for agro-environmental measures on grassland. The additional regional payment of 302 EUR ha^{-1} raises the TGM significantly.

IV. CONCLUDING REMARKS

The results of scenario calculation of CAP reform scenario in Baden-Württemberg illustrate several changes of the investigated indicators.

Increasing total gross margin (TGM) indicates that the agricultural income in the final status of CAP reform in Baden-Württemberg in combination with increased prices and crop yields will increase differently in NUTS3 districts. Districts with a higher share of arable land show a higher variance of the increase than grassland districts.

Increased productivity results in an increase of Nitrogen input from agricultural production.

The agricultural land use in the complete model region does not change significantly. Marginal arable land tends to be converted into grassland.

For the current status and future of ACRE's development we conclude following aspects:

The extension of the model makes it possible to simulate agricultural production for the complete German Federal State Baden-Württemberg (located in the South-West of Germany).

The version of ACRE, for Baden-Württemberg could be used as suitable tool to support/consult decision makers on federal state level (e.g. for stakeholders of the MRL (Ministerium für Ernährung und Ländlichen Raum, Baden-Württemberg = the agricultural ministry of Baden-Württemberg), LEL (Landesanstalt für Entwicklung der Landwirtschaft und der Ländlichen Räume = Research Institution of the MRL).

Comparison of model results with other models (e.g. RAUMIS, which calculates for complete Germany on NUTS3-level) can be used to validate ACRE model results.

With respect to the ACRE version, which is used in the project GLOWA-Danube an extension of this model for all NUTS3 districts in Bavaria could be a useful project, to develop an equivalent tool for this federal state as for Baden-Württemberg.

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