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RESOURCE ADJUSTMENT AND EUROPEAN AGRICULTURE

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Productivity growth and factor adjustment in EC-agriculture

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1. Introduction

Over the last two decades the output of EC agriculture has grown more than two times as much as the demand. In the 60ies and early 70ies this has led to a closing up of import gaps, followed by increasing surpluses on most agricultural markets, the consequence of these developments being an escalation of budget expenditures and conflicts with trade partners.

Meanwhile it has become generally accepted that the increase of agricultural production in the EC has to be reduced. But there is no agreement concerning the ways and means to bring this about. We will not go into detail about these matters here. Instead this paper centres

- on the forces which determine the dynamics of production growth in EC-agriculture
- and the nature and dimension of structural adjustment problems, EC agriculture would be confronted with, if a marked reduction of production growth will be brought about - by which measures ever.

We think that the analysis of these factors is one of the keys for the understanding of the difficulties and diverging views on CAP reform.

The analyses of this paper are based on the data base of the SPEL-model (SPEL= Production and income model for the agricultural sector of the European Community). Some characteristics of this data base are explained in the annex of this paper.

2. Patterns of production growth

Agricultural production in the Community has expanded steadily over the last two decades. From 1965 to 1985 total production has increased by about 40%, that corresponds to an average growth rate of nearly 2% per year.

However there are major differences in the rates of change for the various production branches. On the crop side, cereals and oilseeds showed the largest increases, while the production of "special cultures" (vegetables, fruit, wine and olives) stagnated in most countries. Within animal production, pig and poultry expanded most.

The average rates of production growth vary markedly between the EC-member states. They range from 1.5 % to 4.3 % per year, or

from 30% to more than 100% over the whole period of the two decades (table 1):

- by far the highest production growth has been realized in the Netherlands, with large production increases in the animal sector as well as on the crop side
- growth rates slightly above average growth rates could be observed in Ireland, Belgium, the United Kingdom and Greece, with the two latter countries having especially large increases in the crop sector
- in France, the growth of crop production has also exceeded average growth, but the growth of total agricultural production runs parallel to the average growth of EC-10
- production increases were below average in Germany, Italy and Denmark

Table 1: Development of production volume in EC agriculture

	D	F	I	Nl	B+L	UK[6]	Irl	Dk	Gr	E-10
1. Average annual growth rate[1] % 1965-1985										
Total	1.7	1.8	1.6	4.2	2.2	2.2	2.9	1.5	2.6	1.9
crop production	1.7	2.2	1.1	3.9	2.0	3.2	2.8	2.3	3.5	1.9
cereals	2.4	3.6	1.6	-1.5	1.0	4.5	4.5	1.7	3.8	2.9
root crops	-2.2	1.5	-1.0	2.4	2.7	1.0	0.8	2.7	3.5	0.2
forage	-0.2	0.8	-0.3	-2.9	0.4	-	1.4	-0.1	-0.2	1.3
permanent crops and vegetables[2]	2.0	-0.0	0.9	2.1	1.8	0.8	2.2	0.7	3.7	0.8
other crops[3]	2.6	3.8	3.0	7.9	1.9	4.0	1.0	4.5	1.7	3.2
animal production	1.5	1.5	2.3	4.3	2.0	1.5	2.9	1.2	1.0	1.9
milk	1.1	1.1	1.2	3.2	0.5	1.3	2.4	0.0	-3.2	1.3
cattle	1.9	1.6	-0.1	2.9	3.0	2.6	3.2	-0.1	-2.9	1.7
pigs[4] and poultry	1.7	2.5	4.0	5.8	3.0	1.2	1.5	2.0	3.6	2.6
other animal prod.[5]	0.8	0.4	4.0	5.3	4.8	0.6	1.3	5.2	2.0	1.5
2. Share of branches of production in value of gross production % (average of 1980-1985)										
crop production	36.7	48.3	58.6	33.1	33.3	40.0	22.8	33.0	66.5	44.8
cereals	14.3	19.3	12.1	1.7	6.5	18.3	7.0	19.7	13.4	14.4
root crops	5.4	3.3	3.5	6.0	7.0	5.6	3.8	2.9	3.9	4.4
forage	3.1	4.6	1.1	2.0	2.8	5.4	8.8	1.4	1.5	3.3
permanent crops and vegetables[2]	7.7	16.2	35.7	9.8	11.7	6.9	2.0	1.7	35.2	16.3
other crops[3]	6.3	4.8	6.2	13.7	5.4	3.9	1.2	7.4	12.6	6.3
animal production	63.3	51.8	41.4	66.9	66.7	60.0	77.2	67.0	33.5	55.3
milk	28.2	20.8	15.7	31.2	24.4	23.2	34.6	25.6	4.4	22.3
cattle	10.5	13.6	6.4	6.6	12.2	12.2	27.9	6.0	4.5	10.6
pigs[4] and poultry	24.0	13.2	15.4	27.6	29.1	18.9	9.7	32.7	9.6	18.6
other animal prod.[5]	0.8	4.1	4.0	1.4	1.0	5.7	5.1	2.8	14.9	3.7

1) calculated on the basis of moving three years averages of chain index numbers
2) includes fruit, citrus fruit, vegetables, wine and olives
3) includes dried pulses, industrial crops and oilseeds
4) including output from activity "pig breeding"
5) including sheep
6) the aggregates "total" and "crop production" do not include forage

The considerable differences of growth performance between the EC-countries can be attributed

- to differences in the "composition of production" (different shares of "growth branches" and "stagnating branches"), and

- to divergent trends of growth within the production branches, which reflect differences in natural and in economic conditions and in economic behaviour of farmers ("production dynamics")

A shift analysis[1] shows (table 2), that the deviations of growth performance are mainly determined by differences of "production dynamics". Only in a few countries the specific production composition has an appreciable influence. A favourable composition of production contributes to production growth in Greece and Denmark, while an unfavourable composition has a negative impact on production growth in Ireland and Germany.

Table 2: **Average annual deviation of national growth rates of physical production from average community growth rate (E-10)**
period 1965-1985[1]
(%)

	D	F	I	Nl	B+L	UK	Irl	Dk	Gr
deviation of output growth	-0.19	-0.02	-0.25	2.32	0.28	0.31	1.01	-0.35	0.76
dynamic component	-0.11	-0.04	-0.23	2.25	0.29	0.27	1.21	-0.50	0.54
prod. composition component	-0.07	0.02	-0.03	0.02	0.04	0.04	-0.18	0.16	0.22

1) The calculation is based on moving three years averages of chain quantity indices

Closely connected with aspects of production composition is the aspect of specialization. Other analyses show that in the Community as a whole the degree of specialization has increased on average over the last two decades

In most of the highly specialized member states animal production and especially pig and poultry production are very significant. It is basically found that the more specialized countries have larger growth rates, and that during the course of development specialization is further increasing. This can be interpreted as a tendential adjustment of factor allocation according to the principles of comparative advantage. But this needs more detailed analysis than can be expressed in this paper[2].

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1) In the shift analysis a hypothetical index of physical production is calculated using an uniform production composition (shares of E-10 are being used as weights) for all member states. The growth rates of this hypothetical index are compared with growth rates of the ordinary index of physical production for the member states and E-10 to isolate the two components of production growth.

2) See: Ostermeyer-Schlöder, A.: Die Entwicklung der Agrarsektoren in den Mitgliedstaaten der Europäischen Gemeinschaft vor dem Hintergrund der Europäischen Wirtschaftsintegration, Unveröffentlichtes Manuskript Bonn 1987

Increases of average yields in crop production exceed output growth by far. On average yield coefficients in EC-10 increased by 2.3% p.a. compared to production growth of 1.8 p.a.. This is due to the general reduction of land used for crop production and to shifts in production composition. Differences in production growth in the crop sector can be mainly put down to differences in the development of yields.

3. Sources of production growth

Production growth is determined by
- the changes of factor input and
- the increase of factor productivity.

In the following we will outline the characteristic developments of factor input and the dimensions of productivity growth in EC-agriculture, which are the driving forces of production expansion.

3.1 Development of factor input

During the last two decades the characteristic features of input change have been (table 3):
- a continuous increase of intermediate inputs and of capital input
- a rapid reduction of labour input and
- a slight reduction of land input

Table 3: **Agricultural production, factor input and productivity growth in the European Community (EC-10 resp. EC-9) (Average annual growth rates %)**

	1965-70	1970-75	1975-80	1980-85	1967-84
Production	2.3	1.7	2.4	1.3	1.9
total factor input	-0.2	-0.3	0.7	-0.1	0.1
Intermediate inputs					
Total	2.1	1.5	2.6	1.4	1.9
crop production	3.0	1.9	2.9	1.5	2.4
animal production	2.1	1.2	2.5	1.2	1.8
labour[1]	-4.0	-3.1	-2.5	-2.8	-3.0
capital[1]	4.7	3.4	2.0	2.4	3.2
of which					
buildings	1.6	3.2	1.4	2.2	2.3
mach.a.equipments	6.4	3.6	2.3	2.5	3.6
land	-0.4	-0.3	-0.3	-0.3	-0.3
Productivities					
Intermediate inputs productivity	0.3	0.2	-0.3	-0.1	-0.1
labour productivity[1]	6.0	5.0	5.1	3.9	5.0
capital productivity[1]	-2.3	-1.8	0.4	-1.0	-1.3
land productivity	2.8	1.9	2.7	1.5	2.2
total factor productivity[2]	2.4	1.7	1.6	1.3	1.7

calculated on the basis of moving three years averages of chain index numbers
1) E-9 2) Divisia index

The overall use of intermediate inputs has increased at approximately the same rate as total agricultural production. This means that on average productivity of total intermediate inputs virtually remained unchanged over the whole period. The use of intermediate inputs in crop production has increased somewhat faster than in animal production, so that the productivity has slightly decreased in the crop sector and has increased in animal production. The large increase of the use of intermediate inputs is closely connected with the realization of yield increasing technical progress in plant and animal production, which enabled inputs and yields to increase in the observed magnitudes.

A look at country specific developments shows marked differences of intermediate input growth, also in relation to production growth. By far the largest increase of intermediate inputs took place in the Netherlands, while the large production increase in the United Kingdom has been realized inspite of a rather slow increase of intermediate inputs.

Table 4:

Intermediate Inputs Productivity
Average annual growth rates % per year
1966-1985[1]

	D	F	I	Nl	B+L	UK[6]	Irl	Dk	Gr	E-10
Total	-0.3	-0.2	-0.5	-1.1	0.3	2.1	-0.2	0.2	-0.4	-0.1
crop production	-0.3	-1.6	-2.1	1.5	0.9	4.0	-2.3	0.6	-1.0	-0.5
cereals	-1.6	-2.2	-2.4	-1.2	-0.1	1.7	-3.7	0.2	-2.2	-1.1
root crops	-2.1	-1.6	-2.1	-2.0	0.9	2.9	0.1	1.6	0.1	-0.5
forage	-2.0	-2.0	-2.8	0.9	0.1	-	-4.0	-1.2	-3.2	-0.8
permanent crops and vegetables[2]	2.4	-1.5	-2.3	0.9	0.8	3.2	-2.7	1.4	-1.0	-0.4
other crops[3]	-2.7	-3.1	-0.1	0.4	0.6	2.1	-1.1	-0.2	-1.5	-1.4
animal production	-0.4	0.4	0.6	-1.7	0.0	1.4	0.5	0.1	-0.7	0.1
milk	-0.6	-0.6	-0.3	-2.5	-0.1	0.7	-0.1	-0.5	-0.7	-0.5
cattle	0.1	0.9	0.9	-0.6	0.4	2.1	0.5	0.5	-2.1	0.7
pigs[4] and poultry	-0.4	0.9	0.6	-1.3	0.1	1.7	0.6	0.3	-0.9	0.3
other animal prod[5]	-1.5	1.0	1.3	-1.2	-0.4	0.9	-0.1	0.3	0.6	0.5

1) calculated on the basis of moving three years averages of chain index numbers
2) includes fruit, citrus fruit, vegetables, wine and olives
3) includes dried pulses, industrial crops and oilseeds
4) including output from activity "pig breeding"
5) including sheep
6) the aggregates "total" and "crop production" do not include forage

Capital use is characterized by capital flows, which are derived from capital stock estimates on the basis of the perpetual inventory method (see annex II). Over the whole period, capital use in EC-agriculture has increased somewhat more than total output and intermediate input. During the last decade its growth rate has slackened off, because the investments in buildings and machinery have been reduced drastically, presumably as a result of a more restrictive price policy and a deterioration of the agricultural income situation. This strong reduction of investments will result only with some retardation in a slower growth or even reduction of the capital stocks and of capital use.

Capital use in the EC-countries followed rather divergent trends and the growth rates indicate a certain correlation to the growth of intermediate inputs. Remarkable is the relatively low increase of capital use in the United Kingdom and the rather large increase in Italy, especially behind the background of production growth in these countries.

Table 5: Factor input and productivity growth in the EC member states average growth rate 1965-1985

	D	F	I	NL	B+L	UK	IRL	DK	GR	E-10
total factor input	-0.0	0.1	-0.6	2.6	0.0	-0.3	0.9	-0.1		0.1
Intermediate inputs	2.0	2.0	2.1	5.4	1.8	0.1	3.1	1.3	3.0	1.9
of which										
crop production	2.0	3.8	3.3	2.6	1.1	0.0	5.2	1.7	4.5	2.4
animal production	2.0	1.1	1.8	6.4	2.2	0.2	2.3	1.0	1.8	1.8
labour	-4.0	-2.8	-2.8	-1.4	-4.1	-2.4	-3.7	-3.8	-2.3	-2.9
capital	2.6	3.9	5.0	3.8	2.1	0.3	4.4	2.1		3.2
of which										
buildings	2.2	3.1	4.8	1.9	2.5	-3.0	2.6	-2.3		2.1
mach.a. equipm.	3.4	4.5	4.9	6.5	1.4	1.9	4.7	5.6		3.9
land	-0.8	-0.4	-0.7	-0.6	-0.8	-0.1	1.1	-0.3	0.2	0.3
Productivities										
Intermediate inputs productivity	-0.3	-0.2	-0.5	-1.1	0.3	2.1	-0.2	0.2	-0.4	-0.1
labour productivity	5.9	4.8	4.5	5.7	6.5	4.7	6.9	5.6		5.0
capital productivity	-0.9	-2.0	-3.2	0.4	0.0	1.9	-1.4	-0.6		-1.3
land productivity	2.5	2.2	2.3	4.9	2.9	2.3	1.8	1.8	2.5	2.2
total factor productivity	1.4	1.6	2.2	1.5	1.7	2.2	1.7	1.6		1.7

1) E-9

Labour input in EC agriculture has decreased over the whole period at a rate of 3 % p.a. However the last decade saw a much smaller decrease than the preceeding decade, as a consequence of the unfavourable general unemployment situation.

The rate of reduction of labour input shows significant differences between the EC-member states, which are influenced by the different general economic conditions, farm size structures and expansion rates of agricultural production. The largest reductions took place in Belgium/Luxemburg, FR Germany and Denmark, while reductions were below average in Greece, France, the United Kingdom and especially in the Netherlands. The rate of decline was no more than 1.5 % in the Netherlands, that is less than half of the average rate in EC-10.

Total agricultural acreage has declined slightly in EC-10 by 0.3% p.a.

The largest reductions took place in Germany, Belgium, the Netherlands and Italy, while Ireland is the only country where agricultural land use has increased.

Total factor input[3] has been virtually stagnant over the whole two decades in EC-10 (table 3). That means that nearly the whole production increase has to be attributed to productivity growth. Also, in most EC-countries the changes of total factor input have been rather moderate (table 5). Only in the Netherlands growth of total factor input has been significant.

The shares of the different components of factor input are shown in tables 6 and 7. By far the most important category are the intermediate inputs. Their share increased steadily and reached more than 50% in most countries in the last decade . Only in Italy and Greece it is much lower. In the field of the primary inputs labour shows the largest share, ranging from 20 to 30% of total input in most countries.

Table 6: **Shares in value of total input (%) European Community (E-10 resp.E-9)**

	1965-69	1970-74	1975-79	1980-85	1965-85
total factor input					
Intermediate inputs					
Total	44.2	47.1	51.1	53.1	48.9
of which					
- crop production	24.8	25.8	27.9	31.4	27.7
- animal production	75.2	74.2	72.1	68.6	72.3
Labour[1]	38.1	35.1	33.1	31.2	34.2
Capital[1]	7.9	9.0	9.2	9.8	9.0
Land	8.1	7.6	5.7	4.9	6.5

1) E-9

Table 7: **Shares in value of total input (%) in EC member states average 1980-1985**

	D	F	I	NL	B+L	UK	IRL	DK	GR	E-10
Intermediate inputs	62.9	53.8	35.7	57.1	62.8	61.9	56.6	62.4	29.7	53.1
of which										
crop production	24.2	32.5	26.5	20.2	24.7	30.9	21.8	23.1	47.6	27.7
animal production	75.8	67.6	73.5	79.9	75.3	69.1	78.2	76.9	52.4	72.3
labour	21.9	32.8	49.3	29.1	24.9	21.5	28.3	23.4		31.2
capital	11.2	8.4	11.6	10.4	8.2	8.8	4.9	8.0		9.8
land	4.0	5.0	3.4	3.4	4.1	7.8	10.2	6.3		4.9

1) E-9

3.2 Productivity growth

Productivity growth has been the driving force of the increase of agricultural production. Over the whole two decades the growth rate of total factor productivity was 1.7 % p.a. in EC-10 (Table 3). But in the course of time this rate has decreased stepwise from 2.4 % p.a. at the end of the 60ies to 1.3 % p.a.

3) Total factor input has been computed on the basis of a set of assumptions, which is described in annex II.

in the first half of the 80ies. This is mainly the result of a more moderate labour migration and a lower increase of agricultural output. Looking at the changes of partial labour and land productivities, this fact becomes apparent.

Between the EC-countries the longer-term growth rates of total factor productivity show only moderate differences, ranging from 1.4% p.a. (Germany) to 2.2% p.a. (Italy).

In all countries the changes of partial productivities follow the characteristic pattern which corresponds to the general tendency of factor input changes:

- a very high increase of labour productivity (EC-10: 5 % p.a.)
- a high increase of land productivity (EC-10: 2.2 % p.a.)
- little changes of intermediate inputs productivity (EC-10: -0.1 % p.a.)
- a slight decrease of capital productivity (EC-10: -1.3 % p.a.)

These changes of total and partial productivities are key parameters, if we ask in the following for the consequences of a reduction of agricultural production growth for factor adjustment in EC agriculture.

4. Problems of factor adjustment

The necessary reduction of agricultural production growth will have far-reaching consequences for factor allocation. We will not go into the details of specific market developments in this paper, the dimensions of factor adjustment will be discussed from a more global point of view.

4.1 A rough survey on the required factor adjustments

The global market developments in EC-10 as a whole can be characterized as follows: The growth of production has exceeded the growth of domestic demand by about 1,4% p.a. This corresponds to an increase of the average degree of self-sufficiency from 97% in 1974 to 112% in 1984[4].

If these trends of production and demand growth went on for the next decade, the degree of self-sufficiency would increase by another 15%. This means that the overall volume of "surpluses"

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4) Three years averages 1973/74/75 and 1983/84/85. Based on : Thiede, G.: 10 Jahre Versorgungsberechnungen für die EG, Agrarwirtschaft 33(1984), S. 136-142; Thiede, G.: AGRA-EUROPE 18/87 (4.5.1987), Markt+Meinung P. 1

would double during the next decade. This simple extrapolation shows that past trends have to change in order to avoid a further escalation of budget expenditures and trade conflicts.

A fundamental change of demand developments is at present not in sight. It is true that as far as domestic use is concerned a certain increase of the demand for non-food uses of agricultural products can be expected. But an evaluation of the market potential shows that it would be already optimistic to expect that this could compensate for the effects of a further slowdown of demand growth for food products. Also, the chances for an increase of EC-exports on the world markets seem to be rather gloomy. We are not going into details about demand development in this paper. It is assumed that an increase of demand growth compared with the trends of the past decade cannot be expected.

As a consequence the adjustments will have to take place on the supply side. If we assume as a working hypothesis that it is aspired that the degree of self-sufficiency (the volume of surpluses) will not increase furthermore, then the growth rate of total agricultural production would have to be reduced by 1.4% p.a. This means that production growth would be less than one third of what it has been in the last decade. This is an enormous task, which will need a major political effort and will have far-reaching consequences for factor allocation and production structures in EC agriculture.

We can get a first rough idea of the magnitudes of the necessary factor adjustments if we start our considerations with the (oversimplifying) assumptions,

- that the growth rates of factor productivities will not change as against the last decades
- and that all factor inputs will be reduced according to their productivities.

Under these assumptions the following changes of factor input would have to be brought about:

- Labour input would have to be reduced by more than 4% p.a. This has to be seen against the background that the average reduction rate has been 3% p.a. over the last two decades, and that it has been much lower during the last decade influenced by general unemployment problems. That means that the migration rate would have to be increased by more than 50% as against the present situation.
- Agricultural land use would have to be reduced by additionally more than 15% over the next decade.
- The growth of intermediate inputs use would have to be reduced to less than one third of the trends of the past.
- The growth of capital input would have to be halved. This is a process, which has already started.

The necessity of reducing agricultural factor capacity could be weakened if the rate of productivity growth was smaller in the future as opposed to the past. Is this to be expected? Neither

empirical analyses nor the judgement of scientists in the field of biotechnical research indicate that the contiunous stream of technical progress will slow down during the next decade. The slower growth of total factor productivity, which has been observed in the last decade (see section 3.2) seems to be more determined by less efficient factor use (increase of hidden unemployment, milk quotas) than by a reduction of the growth of the technological potential. On the contrary, if an additional outflow of production factors will be realized and if the eliminated factors (land, livestock, labour) are productive below average, then productivity gain might even increase for some time. Only in the long-run a restrictive price policy and slower production growth might reduce the incentives for yield increasing technical progress. Furthermore, environmental restrictions might reduce productivity growth in the long run. But for the next decade it can be expected that productivity growth will not be affected considerably.

After having discussed the dimensions of necessary factor adjustments the question arises which categories of input factors should be reduced. General considerations on resource allocation lead to the conclusion that it would be advantageous to reduce the input of those production factors, which can be profitably transfered to other sectors of economy. Among the agricultural production factors these are mainly industrial intermediate inputs, capital and those members of labour force, which have alternative employment opportunities.

These preliminary considerations give you a rough idea on the design of political strategies and programmes. For more detailed analysis it is necessary to have a closer look at the different sectors of agricultural production.

4.2 Adjustment problems in the field of crop production

At first glance, a reduction of intermediate inputs, especially of yield increasing inputs as fertilizers and pesticides, appears to be an appropriate starting point of reflections on reducing production growth. The reduction of yield increasing inputs could have an immediate and significant output effect. But because of high marginal productivities of these inputs, drastic political measures would be necessary to bring about a significant impact. These could be either direct quantity restrictions, e.g. quotas for nitrogen, or prohibition of certain pesticides, or drastic economic incentives. Calculations on the basis of production functions for yield increasing inputs show that e.g. a tax on nitrogen of about 400 to 500% would be necessary to achieve a noticable reduction of yield increase. Although such measures are often supported because of their assumed positive impact on environment, we do not expect - for reasons we have not the time to point out here - that they will be applied with an intensity, which is high enough to have a marked influence on the growth of crop production during the next decade.

This judgement is of crucial importance for the agricultural adjustment process: If the intensity of production per ha cannot be influenced noticeably - at least in the short and medium run - then land and yield increasing inputs have to be considered as a package. This means that a reduction of the growth of crop production can be brought about only by a reduction of the whole package, of land and of yield increasing inputs employed on that land. Principally this could be realized by the following political measures:

(1) by a reduction of the prices for crop products, which would lead to a decrease of ground rent and - if some threshold of price reduction is reached - to a giving up of land use in its present (intensive) forms on marginal locations

(2) by economic incentives to reduce the agricultural land capacity, e.g. a premium for the conversion of agricultural land into land used in another way or for land diversion

(3) by direct political interventions in the form of quotas or restrictions on land use, e.g. the obligatory regulation that a certain percentage of agricultural land has to lie fallow.

We do not want to discuss these political alternatives in detail. As a stimulus for further discussion at this conference we will summarize the quintessence of some modelling work, which has been carried out on the basis of a regional agricultural sector model for the Federal Republic of Germany[5]. The results show:

- a very drastic price decrease would be necessary if one tried to reduce production growth in the short and medium run by price policy alone. The necessary price reduction would be in the range of 30 to 40% of real prices for cereals and competitive crops over the next 5 years. To make the consequences socially tolerable huge amounts of direct income transfers would be necessary, which seem to be neither economically reasonable nor politically acceptable
- on the other hand a continuation of last decades price trends would almost inevitably lead to direct state interventions (quota regulations, obligatory fallow etc.), because in this case indirect incentives as conversion or set-aside premiums would lead to a prohibitive escalation of budget expenditures.
- Therefore much is to be said for a "medium line" which includes a significantly, but not extremely restrictive price policy for cereals and other crops, as well as economic incentives to accelerate factor reduction (land, or labour and land). According to the results of the model calculations a reduction of real product prices of about 20 to 30% over the next 5 years would lead to a marked reduction of land rent, so that a conversion of agricultural

5) Henrichsmeyer, W. and Braune, I.: Consequences of Alternative Agricultural Policy Scenarios for German Agriculture. Manuscript, Bonn July 1987.

land into land used in another way (or land diversion) could already be brought about by rather small additional economic incentives (premiums).

In any case, whether one is in favour of one political line or another, considerable amounts of agricultural land will have to be converted from (intensive) agricultural land use. The modelling results for Germany suggest that about 20 to 30% of the present agricultural crop acreage would have to be converted until the end of the next decade, if a further increase of the degree of self-sufficiency is to be avoided.

Similar orders of magnitude result from the type of rough calculations, we have pursued in this paper for EC-10: Having an average growth rate of yields per ha in crop production of 2.3% p.a. and of demand for crop products of 0.5% p.a. the necessary rate of reduction of acreage would be 1.8% p.a. as against 0,4% p.a. over the last decades. That means that an additional reduction of crop land of about 15% during the next 10 years would be necessary, if the rate of yield increases is not going to diminish and if the surpluses are not to increase any further.

In the short and medium term the considerations on limiting the growth of crop production have to concentrate on yield increasing inputs and land use. Under the circumstances of small and medium sized agricultural holdings prevailing in EC-agriculture a faster reduction of the labour force and an increase in the number of farms closing down would mainly add to the growth of the sizes of the remaining farms but would not at all lead to lower yields per ha and to a slackening of production increases. Yet in the long run the migration of labour gains a crucial importance, when in the turn of the generations new dimensions of farm size and new socio-economic forms of farming (part-time farming, multiple job holding) can emerge.

4.3 Adjustment problems in the field of animal production

The introduction of the quota system for milk has been a basic decision, which will determine the situation of cattle production in the EC for a long time.

Within a quota system the allocation of production factors between groups of farms and regions depends to a large extent on political decisions (e.g. regulations on the transferibility of quotas). In most cases the production structures become rather rigid and unflexible. The assumption that technical progress is not affected by the quota system and will lead to a further increase of the yields of milk per cow and inevitably a corresponding reduction of the number of cows will happen is of major importance for the overall adjustment process of the branches of agricultural production. On certain preconditions it is likely that the use of yield increasing inputs (concentrated feed) will be intensified, and as a consequence the input of

forage and land used for forage production will be reduced. Land and other primary inputs (labour, capital), which are released from milk production will be applied in other branches of production and push production growth in these branches.

Within cattle production more flexible adjustments are possible with respect to the combination of land and concentrated feeding stuff. Moreover, some of the more extensive branches of animal production (sheep, game) could make use of ample farm land at low rents. The possibilities must not be overestimated in the short and medium run since the farm size structures existing in most parts of the EC in most cases do not grant the profitability of those extensive forms of meat production and since the demand potential is limited.

Porc and poultry production are hardly connected with land use and other branches of agricultural production. The links are determined by the absorption of waste rather than by the supply of feeding stuff. The socio-economic importance results from the fact that these branches offer opportunities for supplementary income in small-scale family farms.

4.4 Final Remarks

We can summarize that in the short and medium run a number of components and inflexibilities limit the adjustment possibilities of agricultural production factors. This is especially true in the field of land use, in which changed relative factor scarcities call for less intensive forms of production, in which the existing technologies (shape of production functions) and farm size structures, moreover tend to favour high input/high yield production.

In the long run, the reduction of the agricultural labour force and the creation of efficient farm structures, including flexible forms of multiple job holding, are the most important tasks of the future. They also are a precondition for a better solution of the land use problem. These demands remain true, even if one recognizes that the organisation of land use in rural areas for food production and for other purposes of society will be a permanent challenge for agricultural and regional policy during the next decades.

Annex I:

SPEL model as a data base

The basic data system of the SPEL model forms the basis of the analyses in this paper. The SPEL model (Sectoral production and income model for EC agriculture) is a supply oriented information system for the agricultural sectors of the EC, developed at the Institute for Agricultural Policy at Bonn University in close cooperation with the SOEC Luxemburg[6]. It has been designed for forecasting and policy simulations.

The model is based on the concept of sectoral accounting, but it is disaggregated down to production activities. By this activity based approach the characteristic features of agricultural production and the interdependencies between the various activities can be described. The input-output structure of each production activity is represented by data on production and intermediate inputs in monetary as well as in physical terms including intrasectoral flows. The sectoral accounting framework assures consistency with respect to physical and monetary flows.

Consistency between physical and monetary data requires a specific set of prices for output as well as for input, calculated as unit values from monetary accounts data and their physical equivalents.

These internal prices are used to evaluate intrasectoral flows of items, which are also subject to intersectoral sales. Items, which are exclusively used inside the agricultural sector (such as forage) are valued by cost prices.

Analysing the results in this paper it needs to be emphasized that gross production and intermediate inputs include intrasectoral flows and that weights used for the index calculations are based on the unit values which are part of the basic SPEL model.

Annex II:

Data on primary inputs and calculations of total factor productivity

For the calculation of indices of total factor input and total factor productivity it is necessary to specify data on quantities and prices of primary inputs (such as labour, land and capital).

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6) Henrichsmeyer, W., Wolf, W., Ostermeyer, A.: Outline of a Multi-purpose Information System for the Agricultural Sector. In: A. Dubgaard, B. Grasmugg, K.J. Munk (Eds.), Agricultural Data and Economic Analysis, Maastricht 1984

Labour input in ALU (annual labour unit) is based on the EC farm structure surveys. The time series are filled up by using information on change rates of labour input from Eurostat's Sectoral Income Index and National Statistics.

As there is no suitable statistical information on capital input available - the use of data on linear depreciation does not seem appropriate for productivity calculations - an estimation of capital stocks and capital flows for buildings, machinery and equipment has been carried out.

The time series on capital stocks have been generated on the basis of data on gross fixed capital formation at constant prices using the "perpetual inventory method" by means of a quasilogistic function as an approximation to survival of capital goods[7]. Capital flows are calculated by means of the same function as annual reductions of capital stocks.

The aggregation of all input factors to an index of total factor input requires prices to weight the changes in factor inputs. The determination of prices for the primary inputs is connected with serious difficulties, which result from the lack of data on average factor payments.

Available data such as average earnings of employees in agriculture, average rents per hectare, prices for new fixed capital formation and average interest rates, only represent the remuneration of some proportion of the particular primary factor.

As a large amount of labour in agriculture is supplied by family workers and a high proportion of farmland is owned by the farmer the use of these data can lead to a biased value of total factor input, which can be higher or lower than the value of total production according to the specific circumstances in the country.

In some studies the primary input price which appeared to be least satisfactory is calculated as residual by subtracting the value of all other factor payments from gross production value and dividing this by the physical input of the residual input component[8]. However, fluctuations in production value are then reflected solely in the price of the residual factor, which can lead to distortions in the factor price ratios and in the proportions of factor shares.

For these reasons we have chosen an approach which takes into account approximations of factor prices for all factors. It is assumed, that price data for all three primary inputs are only rough approximations of factor remuneration but that they give a clue of the proportions between the factor prices. Therefore factor payments for all three primary inputs (labour, capital

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7) Segger, V., Weinschenck, G., Weindlmaier, J.: Vorausschätzungen für den Agrarsektor - Prognosen der Entwicklung der Agrarstruktur und des Faktoreinsatzes in der Landwirtschaft der EG. Kommission der Europäischen Gemeinschaften (Hrsg.), Mitteilungen über Landwirtschaft Bd. I (No. 64), Bd. II (No. 65), Bd. III (No. 66) 1979

8) Behrends, R.: Vergleichende Analyse der Entwicklung der Produktionsfaktoren in der Landwirtschaft der Europäischen Gemeinschaft. Agrarwirtschaft Sonderheft 90, Hannover 1981, P. 56

and land) are adjusted in order to ensure the identity of the value of total production and of total factor input.

It should be noted that the factor shares for capital input are computed on the basis of prices for fixed capital formation and no return on capital is included as information on real rates of interest in agriculture is not available and interests are considered to be rather low. The use of an average rate of interest in economy would probably lead to an overestimation of the marginal product of capital[9].

These prices form the basis of the weights which are used for the calculation of indices for

- total factor input and
- total factor productivity.

Gross productivity is calculated according to the method of Divisia-Index. From the theory of index numbers can be derived that Divisia index numbers of total factor productivity correspond to a general translog production function.

Acknowledging the validity of the assumptions of the neoclassical theory of production which are:

- marginal products in terms of value correspond to factor payments,
- total production in period t corresponds to total factor payments in period t and
- constant returns to scale

these productivity indices are an exact measure of the shifts of production function. Changes in total factor productivity measured in this way are equivalent to neutral technical progress[10].

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9) Behrens, R., ibd., P. 55

10) Diewert, W.E.: Exact and superlative index numbers. " Journal of Econometrics", Vol. 4 (1976) P. 115-145

Hulten, C.R.: Divisia Index Numbers. "Econometrica", Vol. 41 (1973), No 6, P. 1017-1025

Ostermeyer, A.: Produktivitätsentwicklungen in der Europäischen Gemeinschaft - Theoretische Grundlagen und empirische Vergleichsrechnungen. Diplomarbeit Bonn 1981