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**PATTERNS AND CAUSES OF GROWTH OF EUROPEAN AGRICULTURAL PRODUCTION,
1950-2005**

Miguel Martín-Retortillo^{*} and Vicente Pinilla⁺

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ABSTRACT

The aim of this work is to analyze the evolution of agricultural production in Europe after World War Two. To study the evolution of production, we want to find the causes of its growth. We will start with the role played by the factors of production. We will also want to estimate the contribution to output growth from improvements in efficiency, for which we will calculate the total factor productivity growth. Preliminary results show three possible patterns to explain the evolution of agricultural production. The first one which included Western countries and Germany based their growth in the raised efficiency and a higher use of capital. The opposing model is that of the countries with centrally planned economies. In this group of countries the use of capital was crucial. The efficiency of the system improved, but by considerably less than in the rest of Europe. The intermediate situation is that of the lesser developed countries in the southern European periphery and the Nordic countries, but in distinction to those of the Soviet bloc, they tended to converge much earlier with the model of the Western countries.

Keywords: Agricultural productivity, European agriculture, European economic history

RESUMEN

El objetivo de este trabajo es analizar la evolución de la producción en la agricultura en Europa después de la Segunda Guerra Mundial. Para ello, estudiaremos las causas del crecimiento de la producción agraria. Comenzaremos nuestro análisis con el papel jugado por los factores productivos. Además, también queremos estimar la contribución de las mejoras en la eficiencia en el crecimiento de la producción, para lo que calcularemos el crecimiento de la Productividad Total de los Factores. Nuestros resultados muestran tres patrones para explicar la evolución de la producción en la agricultura. El primero, que incluye a los países noroccidentales y Alemania, basa su crecimiento en aumentos de la eficiencia y el capital, en proporciones similares. El modelo opuesto es el de los países de Europa Central y Oriental. En este grupo de países el incremento en el uso de capital fue crucial. En cambio, la eficiencia mejoró, aunque en menor medida que el resto del continente. La situación intermedia es la de los países menos desarrollados de la periferia del sur de Europa y los países nórdicos, aunque a diferencia del bloque soviético, este grupo de países tendió a converger más rápidamente hacia el modelo de los países occidentales.

Palabras clave: Productividad agraria, Agricultura europea, Historia económica de Europa.

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PATTERNS AND CAUSES OF GROWTH OF EUROPEAN AGRICULTURAL PRODUCTION, 1950-2005*

1. Introduction

Although in the world as a whole agriculture still occupies over 1,300 million people, or 40% of the active population, in the developed countries it has come to play a greatly reduced role in the economy. In recent decades the changes this sector has undergone has permitted it to increase production rapidly, replacing the productive factors most commonly used in traditional agriculture (land and labour) by capital; it has in addition made increasing use of new technologies.

This intensive process of agricultural transformation in the developed countries (and also that experienced later by developing countries) has been the subject of close attention by researchers. Authors such as Federico (2005 and 2011), Hayami and Ruttan (1985), Mundlak (2000), Gardner and Rausser (2001 and 2002), Evenson and Pinghali (2007 and 2009) or Grigg (1982 and 1992) have contributed to an improved understanding of the modernisation of contemporary agriculture, from both the theoretical and empirical viewpoint.

In the opinion of the present authors, such literature nevertheless lacks studies which concentrate, from a long-term perspective, on the transformations which have taken place since the Second World War on the European continent, and which include both the Western countries and those which belonged for many years to the Communist bloc.

The analysis of European agriculture in the decades prior to 1945 or the years immediately following has generated significant interest on the part of researchers, with studies both comparative, of various European countries (Yates, 1960; Tracy, 1964; Dovring, 1965; Van Zanden, 1991; O'Brien and Prados, 1992;), and others which perform diverse national case studies (Lains and Pinilla, 2009; Olsson and Svensson, 2011).

Against this background, our objective is to determine the principal causes of agricultural growth, that is to say the relative contribution of inputs or of total factor productivity (TFP), on the European continent between the Second World War and the

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beginning of the XXI century. Our effort is part of an attempt, for a significant part of European economic history, to extend the analysis of the evolution of the different national cases by using comparative perspectives which include a significant number of countries¹.

We wish to verify whether Europe fulfils the hypothesis of Federico (2005: 221), namely that agricultural growth in this period has been intensive. That is to say, it has been based above all on the increase in TFP, as against the model of extensive growth, based on the increase in inputs, which was characteristic of the XIX century. Yet we intend to go further and attempt to see whether the patterns of agricultural growth were common for the European continent or whether differentiated models can be established.

To achieve the objective proposed we need to calculate the relative contributions made to the growth of agricultural output between 1950 and 2005 by the increase in inputs or in total factor productivity. This requires the previous reconstruction for this time horizon of the series of variables necessary: inputs (labour, land and capital) and output. Part of these data can be obtained directly from the databases of FAOSTAT (2009). In some cases it will be necessary to perform additional estimations and calculations. These estimates have been especially important for the 1950s, for countries with centrally planned economies and for Germany until its unification process. The procedure we shall use to estimate TFP will be that termed the Solow residual, and in particular the methodology of “growth accounting”, which in turn takes into account the possibility that the relative intensity of factor use varies over the study period.

The European continent has certain characteristics which justify our selection and underline its interest. Firstly, we believe it is important that some of the countries which comprise it were pioneers in the industrial revolution, and thus by 1950 had travelled a long way along the path of economic development. Others, by contrast, had been left behind. Additionally, the institutional divergence caused by the division of the continent into two political and economic blocs from 1945 onwards permits us to contrast the importance of institutional factors in the processes of economic growth.

The period on which we shall concentrate, that subsequent to the Second World War, is of great importance. In the agricultural sector, there occurred the massive use of agricultural machinery, chemical fertilisers, pesticides and herbicides, the development of intensive livestock breeding, improved breeds of animals, better access to agricultural credit, the genetic selection of seeds and the expansion of irrigated farming in the Mediterranean

¹ Broadberry and O'Rourke (2010) offer a full and recent synthesis of the economic history of the continent since 1700.

countries (Grigg 1992; Gardner 1996; Evenson and Gollin 2003; Federico 2005; Mazoyer and Roudart 2006; Josling 2009). Furthermore, from the institutional point of view this is a historic period in which was the continent was reconstructed following World War Two. The European Economic Community, the future European Union, was created and subsequently expanded. Finally, various Central and Eastern European countries remained under a Communist regime for over forty years in this period, their transition towards a market economy taking place subsequently.

Our results show that the rapid growth of agricultural output which took place in Europe occurred very differently in different countries. Three different models of agricultural growth can be identified. That of the Western European countries (those most developed in 1950) was principally based on a rapid growth of TFP throughout the entire period. The increase in the use of capital also played a very important role. This was especially important in the decade of the 1950s, tending to decrease from then on.

The opposing model is that of the Central and Eastern European countries, which had planned economies until the early 1990s. Heavy capital investment was crucial in these countries to achieve agricultural growth, while the contribution of TFP was small. Finally, the Mediterranean and Nordic countries are located in an intermediate position. The contributions of capital were higher than in the Western European countries but clearly lower than in the Central and Eastern European countries. In all cases, the fall in the use of land and, above all, workers, was very significant.

To achieve the objective proposed, the present article adopts the following structure. Firstly, we analyse the evolution of agricultural production. Next, we examine the patterns and intensity in the use of productive factors. Subsequently, we analyse the causes of the growth of output: technical progress and the increase in TFP. The study ends with a conclusions section.

2. Evolution of net agricultural production

Table 1 shows that European agricultural production increased sharply from 1950 until the mid-1980s, from when on it stagnated.

The evolution of production can be analysed in greater detail. It is observable that post-war recovery was rapid. Despite the serious distortions and destruction caused by the war, by 1950 the pre-war level of production had not only been reached once more but greatly exceeded. In general, the greater the involvement of a country in the conflict, the smaller was

the increase in its production. Two cases are notable for their slow recovery. The first is that of the German Federal Republic, which by 1950 had not yet recovered its pre-war level. The second is Spain, which did not participate directly in the conflict and had ended its civil war in 1939; it was gravely affected by the subsequent policies of the Franco dictatorship and the international isolation of the country (Clar and Pinilla, 2009).

[Insert table 1]

Following the recovery immediately subsequent to World War Two, a further sharp increase in production took place in the 1950s. In the market economies the annual growth of production was 2.8% between 1950 and 1962. In those years there was great institutional preoccupation with resolving the food shortages of the war and subsequent years (Glynn and Booth 1996; Dormois 2004). The agricultural sector was also considered to have a strategic role to play in the economy. In addition, the sector employed a great number of workers in those years (Andreosso–O’Callaghan 2003). Encouragement was given to improve access to agricultural credit and favour in this way the capitalisation of the sector.

For example, France dedicated part of its resources from the Marshall Plan to distributing fertilisers and mechanical equipment (Dormois 2004, Josling 2009 and Zamagni 1993). In general, the Western European countries implemented support policies for their agricultural sectors; these increased state intervention in the sector and stimulated production. In imitation of the state intervention in agriculture initiated in the United States during the Great Depression, and continuing the policies of the control of production and consumption developed during World War Two, the Western European countries ended the free market in the agricultural sector. Agricultural policy explicitly sought self-sufficiency in food and an increase in agricultural productivity in the European countries (Fennell 1997, García Delgado and García Grande 2005, Landau and Tomaszewski 1985, Lampe 1986, Neal 2007). The new technological supply available made it easier for these innovative policies to boost a strong increase in production.

Furthermore, certain countries displayed spectacular growth in that decade. Thus, in the United Kingdom, in the period between the Second World War and the mid-1960s there took place the greatest growth in agricultural output since the 1870s (Brassley, 2000). Another notable case is that of the Federal Republic of Germany, whose production rose by almost 4% annually; the 1950s and 1960s have been described as an “economic miracle” (Wilson and Wilson 2001).

In the countries of the Communist bloc the change in agricultural structures was total, as the consequence of the implantation of the Soviet model. Planning also boosted production, specifically at an annual growth rate of 2.33% in the 1950s². Despite this impulse, there was a continuance of the distortions which began with the institutional changes following the war, due to the processes of collectivisation and price and salary regulation (Berend and Ránki 1985, Landau and Tomaszewski 1985, Lampe 1986, Pryor 1992, Anderson and Swinnen 2009).

In the context of an important institutional concern for the agricultural sector, the European Economic Community was formed and the Common Agricultural Policy established. This meant no radical break with the previous policies of the member states, but instead a homogenisation and convergence among them. The objectives for the agricultural sector contained in the Treaty of Rome were the increase of productivity, the guarantee of reasonable prices, the achievement of an equitable standard of living for farmers, market stability and guaranteed supply. The development of this treaty, through the CAP, left its mark on the agricultural sector for decades, especially until 1992 and the MacSharry reform.

The CAP, during the first decades of its life, fixed elevated prices for a substantial part of agricultural production, normally taking as reference the highest price for each product from among the founding countries. This policy of high prices, generally much higher than those in the international market, stimulated an increase in production. The natural result of this policy was also that agriculture in the European Economic Community needed strong commercial protection. It was a system which encouraged the growth of production, because it maintained, thanks to such protection, prices above international levels, and similarly delivered subsidies (Tracy 1989, Gardner 1996, Neal 2007, Andreosso O'Callaghan 2003).

The result of guaranteed high prices, strong protection and the close and deep integration of markets in the member states was a considerable increase in production and productivity, the relatively quick achievement of self-sufficiency in food and a sudden change in the European position in the international markets for agricultural products³. Agricultural trade among the member countries increased considerably, while there was a significant fall in their participation in international markets for agricultural products as importers (Pinilla and Serrano, 2009; Serrano and Pinilla, 2011).

² The GDR was an exception to this growth, as its annual increase amounted to only 0.53%.

³ In various products, this self-sufficiency was achieved relatively rapidly by the end of the 1950s in the countries forming the European Economic Community, but especially in the 1960s and 1970s (Tracy 1989; Fennell 1997).

This growth of production continued in the 1960s and 1970s. In the market economies there was some reduction in the sharp increase in output of the previous decade, which nevertheless grew by 1.7% annually between 1962 and 1972 and by 1.9% in the following decade. The country with the fastest growth was Spain, expanding by 2.7% between 1962 and 1982. This may be explained by the opening of the Spanish economy due to the Stabilisation and Liberalisation Plan in 1959, which produced generalised economic growth and the massive incorporation of Western technology (Prados et al. 2011).

Another notable case is that of the countries of the Communist bloc, with a rapid annual growth of 2.2% in the 1960s and 1970s, although with many differences among them (Gregory and Stuart 2001). There were frequent increases in livestock products and a change from traditional cultivated products towards fruit and vegetables and vines (Landau and Tomaszewski, 1985; Berend and Ránki, 1985; Lampe, 1986).

The 1980s mark a point of inflection, as the growth in output slowed down; in the continent as a whole this increased at an annual rate of only 0.1%. This result is strongly biased by the problems of agriculture in the countries of the Communist bloc, since in market economy countries growth continued, although at a slower pace than in previous decades. In the countries belonging to the Communist bloc the crisis affected their economies as a whole, while agriculture gradually accumulated tensions in the inputs and goods markets⁴ (Anderson and Swinnen, 2009). Throughout this decade agricultural output fell at an annual rhythm of 1.3%.

Problems arose due to the gap caused by the high prices paid to producers and the low prices demanded from consumers; this gap was covered by direct subsidies. Equally, in all these countries the livestock boost produced distortions, because heavy subsidies were required to achieve it⁵, as were massive imports of cereal to meet the needs of livestock feeding. Trade protection in these countries came to mean equivalent welfare losses of between 50 and 75% of the benefits of direct subsidies to consumers (Gray 1990, Anderson and Swinnen 2009). In the German Democratic Republic large collective farms were heavily indebted due to their inefficiency (Forstner and Eisenmeier 2000).

The evolution of agricultural output during the 1990s was very different in the market economies and in the Communist bloc, the latter in the middle of dissolution and a transition

⁴ An example of these tensions occurred in the Soviet Union, which was greatly in need of importing cereals. Due to oil and gas exports there was no problem in financing cereal imports until the mid-1980s, when the prices of energy products fell, harming the financing of these massive imports (Gray 1990).

⁵ Thanks to this boost to the output of livestock activities, per capita consumption of these products increased, outstripping that of the OECD countries, despite the standard of living being lower (Anderson and Swinnen 2009).

towards market economies. On the one hand, the free market countries continued to display very slow growth during most of the decade. An essential change took place in 1992 with the MacSharry reform of the CAP. This meant a departure from previous philosophy in this policy, moving from a pricing policy to one of direct income support. Despite this change, a considerable part of Mediterranean products, such as olives and vines, were not included in this legislative reform (García Grande 2005, Neal 2007). It was also at the beginning of the 1990s that the inclusion of agriculture in the Uruguay Round of GATT meant the start of a liberalisation process in the international markets, which affected the European position⁶.

Elsewhere, the countries of the Communist bloc started their transition to market economies at the beginning of the 1990s. This transition involved serious problems for their economies and, therefore, for their agriculture⁷ (Trzeciak-Duval 1999). There exist differences among countries in the way this transition was performed, and also its effects upon production. It was a stage in which the ex-Communist countries had to undertake important institutional reforms, such as price and trade liberalisation, reforms of the land market and the restructuring of farms, added to extreme meteorological conditions in certain years (Macours and Swinnen 2000 and 2002).

From 2000 on, and for the first time since the problematic years of the war, European production fell at an annual rhythm of 0.3%. Evolution in the first quinquennium of the XXI century has not been exactly the same in all regions. The best results occur in the ex-Communist countries, whose production increased by an annual rate of 0.7%, recovering part of what had been lost in preceding decades. This was due to the progressive overcoming of the institutional problems derived from the transition which they underwent in the 1990s, and also to the implementation of policies aimed at incorporation into the European Union.

3. Input use patterns

Throughout the XIX century, and in some countries also in the first decades of the XX century, an increase in the use of inputs had been the principal cause of the growth of agricultural production (Federico, 2005: 221). However, after 1950 this tendency changed

⁶ European agricultural protection was a constant theme within the GATT and WTO rounds, such as the Kennedy, Tokyo, Uruguay and Doha rounds (Spoerer 2010).

⁷ The problems of the transition from one economic system to another were, among others, the loss of the traditional international markets of COMECON, the monopoly of distributors (which contributed to increasing the difference between prices received by the producer and retail prices), the decrease in disposable income and the reduction of subsidies to the sector, the increase in productive factor prices at worldwide level, a greater uncertainty provoked by the restructuring of the land market, a lack of experience in private management or a shortage of credit (Trzeciak-Duval 1999).

radically in Europe. Thus, there was a fall in absolute terms in the use of productive factors which predominated in traditional agriculture, land and labour, in opposition to capital, the importance of which increased considerably. This capitalisation took place principally as a consequence of an increase in agricultural machinery and chemical fertilizers.

3.1. The reduction in agricultural land area

[Insert table 2]

Since 1960 there has taken place a reduction in the number of hectares employed as arable land in European agriculture. This reduction may be due to various factors. On the one hand, to the abandonment of farms produced by the structural change in the economy throughout the entire period. Furthermore, the increase in the average size of farms and in the productivity of land more easily permitted the achievement of economies of scale and, with a lower quantity of land input, an increase or maintenance of production. On the other hand, to the increase in the importance of livestock products in total production in the initial decades of the second half of the XX century, while the increase in intensive livestock breeding permitted the separation of part of production from the land factor, especially in countries with less favourable environmental conditions, such as aridity, which traditionally had caused limitations when producing biomass for livestock feed (González de Molina 2001).

The cultivated land area increased very slightly, at an annual 0.08%, between 1950 and 1962. In fact this increase took place in the Central and Eastern European countries. In that decade these countries completed their processes of agricultural reform, and therefore the consolidation of farms (Berend and Ránki 1985, Landau and Tomaszewski 1985, Lampe 1986, Pryor 1992). From then on, the decrease in the number of cultivated hectares was generalised and constant in the last four decades of the XX century.

In some cases, such as France, the fall was occasionally more abrupt. An example is the 1960s, when production fell by exactly 1.3% annually. This was due to voluntary policies for the consolidation of farms and the payment of supplementary pensions to old-aged farmers for them to retire (Bouchet et al. 1989). Following this considerable decrease in the French case, a slight increase took place until 2005, although this time it did not recover the level of the early 1960s. In many parts of Europe, the reduction in the cultivated land area was closely linked to the massive rural exodus which took place and which involved the abandonment of many farms, especially those least economically viable (Collantes and

Pinilla, 2011). This was the case of mountainous zones, where the reduction in the cultivated land area was especially notable (Collantes, 2006).

3.2. The capitalisation of agriculture

In the developed countries, the greater use of capital in agriculture has been highlighted as one of its most important features throughout the XX century (Federico, 2005).

In the more arid European zones or those with greatest difficulty in having available sufficient water for the cultivation of certain crops, an extraordinary effort was made in this period to increase the irrigated land area or to improve the quality of irrigation. Between 1961 and 2009 the area equipped for irrigation grew in Europe by 1.56% annually, although the distribution of this increase was enormously unequal throughout the continent. Cases such as Romania, Greece or France increased their irrigated land area at an annual rhythm of 5.9%, 2.7% and 3.5%, respectively. Also notable are the cases of Spain and Italy, which, although having lower growth, in 1961 possessed 10% and 17.9% of the total European land area equipped for irrigation, as a consequence of the actions of the first half of the XX century.

[Insert table 3]

Livestock is a very important part of the capital employed in agriculture, because it produces certain consumer goods such as meat, milk, eggs or wool, and it has been employed as the motor of agricultural production. Thus, Table 3, which displays the evolution of the number of livestock units, is the result of two counterpoised trends. On the one hand, the decrease throughout the second half of the XX century in the number of working animals. On the other, the increasing importance of livestock for the production of meat or milk, especially in countries in which it had been relatively unimportant, as a consequence of their inadequate ecological conditions. The result was that until the early 1980s there took place a significant increase in livestock numbers in Europe, visible in all its regions with the exception of the Nordic countries.

Consequently, in Europe in general livestock production tended to gain importance in agricultural production as a whole until the early 1980s. This improvement in its participation was much more important in those regions where the initial quota was smaller, such as the Mediterranean countries or those of Central and Eastern Europe.

From the beginning of the 1980s there took place an appreciable reduction in this number of livestock. Some of its production was affected in Western Europe by serious problems of oversupply and the change of philosophy in the Common Agricultural Policy,

with a greater environmental concern regarding the control of intensive livestock breeding (Gardner 1996; Andreosso-O'Callaghan 2003; García Grande 2005; Anderson and Swinnen 2009).

The principal exception in the market economies was the continued increase after 1980 of livestock numbers in the area least specialised in this activity, the Mediterranean countries. Thus, in Spain, livestock breeding continued to increase until it almost doubled its units, principally due to the enormous growth of intensive livestock breeding processes (Dominguez 2001). This was due in part to the possibilities offered by such processes; they permitted the mitigation of environmental obstacles traditionally faced by livestock (Pinilla and Clar 2011).

On the other hand, it is necessary to underline the significant reduction in their livestock numbers which the countries of Central and Eastern Europe experienced from the mid-1980s on. The differences which existed in this system between the low prices paid by the consumer and the high prices paid to the producers, which were covered by direct subsidies, brought about a livestock boom, unsustainable once this policy had ended, in the final decades of Communism⁸ (Anderson and Swinnen 2009).

Lastly, within the capital utilized, there was a considerable increase in the purchase of inputs from other sectors of the economy in European agriculture. From an agriculture which basically used inputs from the same sector there was a change to another in which purchases from other sectors were dominant. Principally, these were the purchase of machinery, fertilisers, pesticides, seeds, fuel or services from other companies.

Table 4 shows the evolution of the consumption of fertilisers per hectare. From 1950 until the 1980s there was a very sharp increase in the use of chemical fertilisers in European agriculture. Although growth was generalised, the Western and Nordic countries already had by 1950 higher levels than the Mediterranean and Central and Eastern countries, as the former had already introduced to a greater extent this innovation prior to the Second World War⁹. Thus, the greatest increase in the consumption of fertilisers per hectare occurred in the countries of Central and Eastern Europe, which in 1950 had had the lowest level in the entire continent.

By contrast, from the mid-1980s until the beginning of the XXI century the level of chemical fertilisers used per hectare fell throughout the continent. On the one hand, the

⁸ The per capita consumption of livestock products in the USSR between 1950 and 1980 doubled (Diamond et al. 1983), and was greater than in the Western countries (Anderson and Swinnen 2009).

⁹ The United Kingdom was already consuming almost 1.5 million tons of artificial fertilisers by the second half of the 1930s, while in 1950-1951 use had increased to over four million tons (Brassley 2000).

Western, Mediterranean and Nordic countries reduced their consumption, due to environmental problems caused by the massive use of these inputs (Gardner 1996). On the other hand, the Central and Eastern European countries also drastically reduced their consumption of this input, because of the liberalisation of the factor markets, causing nominal input prices to increase by more than nominal output prices (Anderson and Swinnen 2009), and because of the problems which in general they suffered during their transition to a market economy.

With regard to the use of machinery, well represented by the number of tractors in service per agricultural worker, Table 5 shows an increasing evolution throughout the second half of the XX century (a 7.3% annual increase between 1950 and 2005). Both the Western and Nordic countries already had in 1950, as with fertilisers, a higher level than in the remaining countries. In the United Kingdom the level was already extremely high in 1950 and the adoption of this input took place above all during the 1940s, when the number of tractors quintupled (Brassley 2000).

In the 1950s the growth in the number of tractors per worker was spectacular (14.6% annually between 1950 and 1962)¹⁰. In the 1960s and 1970s the incorporation of tractors per agricultural worker also increased, although at a slower pace than in the preceding decade. In the following decades their use increased still further, despite the rhythm of growth falling once more.

The Western and Nordic countries were the first to introduce this innovation, because the development of their economies preceded that of the Mediterranean, Central and Eastern countries. The security provided by high prices, due to trade protection and subsidies from national policies prior to the subsequent Common Agricultural Policy allowed investment in machinery to be high (Houpt et al. 2010).

[Insert table 4]

During their Communist stage, the countries of Central and Eastern Europe implemented a policy of the massive capitalisation of agriculture, especially of collectivised farms, permitting them to increase the number of tractors per worker at the same rhythm as other countries with market economies (Diamond et al. 1983, Berend and Ranki 1985, Landau and Tomaszewski 1985, Lampe 1986, Gregory and Stuart 2001). Following the

¹⁰ For example, in the Spanish case the number of tractors increased by 16.3% annually between 1950 and 1962, a considerable increase and above average annual European growth (14.6%), despite the administrative barriers which existed (Clar 2009).

transition, this number fell slightly (moving from 0.2006 in 1990 to 0.1807 in 1992), but rapidly increased once more, due also to the decrease in the number of workers.

It is important, lastly, to underline the importance of biological innovations in this process of technological change. The increase in crop yields due to the process of the genetic selection and hybridisation of seeds is fundamental to understanding the sharp increase in agricultural production and productivity (Olmstead and Rhode 2008)¹¹.

[Insert table 5]

3.3. The rural exodus

In the second half of the XX century European agriculture tended to use a smaller labour force. As Table 6 shows, this fall was very intensive, from over 67 million workers to under 15 million between 1950 and 2005. In this reduction, two periods stand out: the first between 1950 and the mid-1980s and the second from the mid-1980s until today. In the first period, the average annual decrease was lower (-2.5%), but in absolute terms almost 37 million people on the continent ceased working in agricultural activities.

In turn, from 1982 until 2005 this annual decrease was still greater (-3.3%). This accelerated fall in the active population in agriculture in the second period is probably due principally to the continuation of the process of rural exodus in the Mediterranean, Central and Eastern countries of Europe. Furthermore, the Central and Eastern countries, in particular Poland, the Czech Republic, Slovakia or Hungary saw considerable exits of workers between 1989 and 1995¹² (Macours and Swinnen 2000).

[Insert table 6]

The exit of workers from European rural zones was directly determined by the need for labour in other sectors. The most advanced countries in Western Europe had already experienced, prior to the Second World War, a very significant transfer of workers from rural to urban zones. Following the end of the conflict, the intense economic growth which took place proved capable of absorbing new and significant contingents of rural labour, especially in the 1950s and 1960s, (Holderness, 1996). The greater attraction of the urban environment

¹¹ The improvement of yields in, for example, wheat or maize was substantial from the 1950s on (Pujol 2011).

¹² The *länder* corresponding to the former German Democratic Republic lost many workers following the transition, since this sector had an excessive labour supply (Huber 2000). The exception to these countries was Romania, which experienced an annual increase in its agricultural labour force of 2.4% between 1989 and 1995 (Macours and Swinnen 2000).

for young generations in these advanced countries contributed to increasing yet further the exit of youths from the rural environment (Josling 2009).

The lower level of economic development in the Mediterranean, Central and Eastern countries of Europe meant a less important rural exodus prior to 1945. Nevertheless, especially in the initial decades of the XX century, interior migrations were of an appreciable intensity in countries such as Spain or Italy (Silvestre, 2005). After 1945 the exit of agricultural workers in them, with the exception of Italy, was still of little importance, but from 1960 onwards accelerated sharply.

In the countries of the Communist bloc, certain policies delayed the replacement of workers by machinery and introduced migratory controls to restrict the mobility of the labour factor (Landau and Tomaszewski 1985).

4. Unravelling European agricultural output growth

We have seen so far how European agricultural production increased spectacularly from the early 1950s until the early 1990s. These four decades of expansion of agricultural output were followed by years in which the most common result was the stagnation of production. We wish now to analyse what has been most decisive in the long-term growth of agricultural production.

In the previous section we were able to establish clearly that in the long term the use of traditional agricultural inputs, land and labour, has decreased notably. This fall in the use of both inputs, linked to the increase in production, has meant a sharp rise in both land and labour productivity (Wong and Ruttan 1990, Martín-Retortillo and Pinilla, 2012). Consequently, the increase in production can only be explained by a greater use of capital or by efficiency gains in the use of inputs. Disentangling which of these factors has been more important requires the estimation of, firstly, how total factor productivity has varied, and, secondly, of the rhythm at which the use of capital in European agriculture has increased.

4.1. An estimation of total factor productivity

We shall calculate TFP in accordance with its primary definition that is to say as the Solow residual (1957). This definition stems from the methodology of growth accounting¹³. We measure TFP indirectly as a residual component of the growth in output which cannot be

¹³ Crafts (2010) states that the methodology of “growth accounting” is the most appropriate to quantify the impact of a new technology on productivity.

explained by the growth of production inputs. This difference is calculated by subtracting from the annual growth rate of production between two years the rate of a combination of inputs. This combination comprises land, measured in hectares of arable land (A); labour, represented by the number of workers who comprise the active population in the agricultural sector (L), plus one measure of the quality of labour, in other words human capital (HK); and physical capital (K), measured as an average among the rates of growth of the number of tractors, tonnes of consumption of fertilisers, hectares of area equipped for irrigation and number of livestock (Table 3, 4 and 5)¹⁴.

This combination of inputs, according to the determinist methodologies of growth accounting, use as weightings the fraction of the output employed to remunerate each productive factor (Del Gatto et al. 2011). Based on Dias Avila and Evenson (2010):

$$G_{TFP} = G_Y - C_L(G_L + G_{HK}) - C_A G_A - C_K G_K$$

where G represents growth rates in variables and C are weightings.

To simplify our calculation, and faced with the difficulty of obtaining for each country the remunerations of the productive factors, we have used the weightings proposed by Federico (2011), which means that the distribution in the initial year of the calculation was 40% for land and labour and the remaining 20% for capital, while for the final year the remunerations of the inputs were equivalent. Thus, we obtain the TFP, which is calculated as the average among the weightings of the initial year and those of the final year for each input (Jorgenson 1991, Olavarria et al. 2004).

The TFP of European agriculture, shown in Tables 7 to 9, experienced an enormous increase throughout the period¹⁵. Nevertheless, its rhythms of growth and its contribution to the increase in output show significant regional contrasts. For the whole period 1950-2005 (Table 7), the growth of production is explained by the increase in TFP and the use of capital, which more than compensated for the fall in the use of land and labour¹⁶. In most Western European countries, the contribution of TFP was lower than the increase in the use of capital,

¹⁴ This combination is based on that used by Federico (2011: 62-66) for his calculation of TFP. Furthermore, we have replaced the geometric average by the arithmetical average to calculate capital growth rates, due to having negative rates of growth for some periods or inputs. It should be observed that our estimation of capital growth, since it does not use other forms of capital, such as seeds, fuel and purchases of inputs from other sectors, involves assuming that its growth was similar to that obtained with the variables which we do use.

¹⁵ Our estimation could have a problem of overestimation, as the increase in part-time work in the period means that the reduction in the use of the labour factor was less marked.

¹⁶ The fall in the use of the quantity of labour is partially compensated for by the increase in the quality of workers.

although these rates are closed themselves. Yet there is an exception within this group of countries; the United Kingdom has a greater increase in TFP than in the use of capital in the whole period. The Mediterranean countries have a higher TFP growth than the European average, but their use of capital increased more than the European level. Furthermore, the difference between the rates in TFP and the use of capital was higher than in the Western countries. In the Nordic countries, the increase in TFP and in the use of capital was lower than in Western Europe. Lastly, in the Central and Eastern countries the increase in the use of capital was much higher than in other European groups of countries.

[Insert table 7]

The fastest increase in TFP took place in the countries of Western Europe and in Spain. The lowest growth rates corresponded to the remaining Mediterranean countries, the Nordic countries, Switzerland and the Central and Eastern countries.

We now analyse the evolution of TFP, and also that of output and inputs, by sub-periods. Table 8 underlines that in the period between 1950 and 1985 the strong growth of output was essentially explained by a very strong capitalisation, especially as a consequence of the generalisation of the use of self-propelled machines and fertilisers, added to the sharp increase in livestock units in some countries such as Benelux, Denmark, Greece, France and Spain. An improvement (very important in the countries of Western Europe and more moderate in the rest) in efficiency in the European agricultural system as a whole also contributed to the strong rise in production, which was achieved while the use of land and labour were already falling; these were the two most important factors in traditional agriculture (Grigg 1992).

[Insert table 8]

Additionally, between 1950 and 1985 a vigorous growth in production was boosted in a relatively balanced way by the growth of capital utilised and of TFP, while the use of labour and land fell. The relative contributions of capital and TFP vary according to countries. In the Western countries TFP growth, together with the two German Republics, was higher than the European average. In the Mediterranean countries, this growth was slightly less than Europe as a whole because of a stronger capitalization process than in the West, as these countries had already begun this process before the war. In the Nordic countries the TFP contribution was lower than the European level, but their output growth was the lowest in the continent;

this, without this increase in TFP, the output decrease would have been larger. In the centrally planned economies, the contribution of capital was the most important, but TFP increased, although slightly. This was due to the majority of countries having concluded the collectivization process (Pryor 1992), which permitted farmers to enjoy a certain institutional stability¹⁷. However, Federico (2005 and 2011) signals a lack of incentives to work on the collectivised farms, and similarly a reformulation of agricultural policy due to the excessive use of capital in a still backward agriculture.

[Insert table 9]

Finally, Table 9, with regard to 1984-2005, displays a change with respect to the panorama observed thus far. The growth of TFP in this period is somewhat lower. The authentic change was produced because capital began to decrease, as had occurred previously with the other productive factors. Furthermore, output was stagnant in Europe as a whole (which is the result of the low growth rates of Western Europe, Germany and the Mediterranean countries, against a fall in those of the Nordic countries and Central and Eastern Europe). These two changes are related. The limitation on the use of composts and fertilisers, due to abuse in preceding decades and the environmental problems it produced, affected production. In fact, this fall in the use of fertilisers is reflected in the negative growth of capital, also produced partly by the slight decreases in the number of animals and of tractors. Thus, it is efficiency gains in the agricultural sector as a whole which permitted slight increases in production, faced with a lower use of all productive factors.

A different case is that of the countries of Central and Eastern Europe, which experienced a sharp fall in their agricultural production, and similarly in the use of inputs, especially labour and capital. This is because of all the problems caused by the economic transition from a centrally planned economy to a market one¹⁸ (Macours and Swinnen 2000 and 2002).

¹⁷ In countries such as Poland this institutional stability was not given, due to various legislative modifications regarding the incentives to invest in collective farms, the dissolution of various cooperatives following a process of forced collectivisation, and similarly the loss of consistency in government action, which permitted farmers to acquire land for crops to avoid urban growth and a rural exodus; in fact, this policy only incentivised the purchase of land for the socialised farms (Landau and Tomaszewski 1985).

¹⁸ There also existed problems in the German Democratic Republic in comparison with the Federal Republic of Germany. In the mid-1990s there existed differences between capital, labour and livestock per hectare, and also between yield per hectare and input quality between the two Republics. Inefficiency in the GDR resulted from the assignation of inputs and the size of farms, not from ownership type (Thiele and Brodersen 1999).

5. Conclusions

European agricultural production grew strongly until the mid-1980s, stagnating from then on. During the first stage a process of intensive capitalisation of the sector occurred, as against reductions in the use of labour and land. Furthermore, sharp increases in productivity permitted the improvement of efficiency in this sector and also the increase of production yet further.

In turn, from the late 1980s onwards the transformation of the productivist model of the Common Agricultural Policy to another in which agricultural income support was partially detached from production, and similarly the transition from a centrally planned system to a market one in the countries of the previous Communist bloc, affected a production which continued to reduce the use of land and labour and, in turn, maintained or reduced the role of capital. Faced with these reductions in factor employment, it was the increases in the total productivity of these same factors which permitted production to be maintained.

The present study has highlighted diverse ways of accomplishing high production growth in the long term. From our perspective we can distinguish two different models and one intermediate one.

The first is characteristic of the countries of Western Europe and Germany. At the beginning of the period, these had a more advanced level of economic development and higher capitalisation of their agriculture. These were based on strong increases in agricultural efficiency, with an annual rate which exceeded 1.50% annually in the 55 years studied. The increase in the use of capital played a very important role, although its significance waned by the end of the period. Capital investment grew extraordinarily quickly in the 1950s, decelerated in the 1960s and 1970s (although it continued to increase significantly) and fell from the 1990s on. This model combined, therefore, a considerable fall in the use of land and, above all, labour, with a significant growth of capital, while efficiency improvement played a stellar role.

The opposing model is that of the countries with centrally planned economies. In them the key to growth in agricultural production was the very strong increases in the use of capital, much higher than those of the Western countries, while the use of land and labour also diminished. The efficiency of the system improved, but by considerably less than in the rest of Europe. In short, their model of agricultural growth resembled that of the set of their economies, in which efficiency considerations had a secondary role compared to the accumulation of the capital factor (and labour in non-agricultural activities). The transition to

a market economy seriously affected their production, and also upset their model of growth, by significantly reducing the use of capital and maintaining efficiency improvement. We can therefore propose a certain, although still timid, convergence towards the other model.

The intermediate situation is that of the lesser developed countries in the southern European periphery and the Nordic countries, although between these two groups there were also important differences. Their development model was based more on the increase in capital than on efficiency improvement, but in distinction to those of the Soviet bloc, they tended to converge much earlier with the model of the Western countries. In the 1950s their growth was based very unequally on the increase in capital, as against efficiency. By contrast, from 1960 onwards, although the use of capital grew rapidly, so did efficiency, at a rhythm which approximated that of the Western countries. From 1985, although in distinction to the Western countries the use of capital continued to increase in the Mediterranean countries, its rhythm was slow and efficiency increased even more quickly than the Western countries. In the Nordic countries the use of capital also fell since the latter date, as in the Western countries.

In summary, the growth of agricultural production in Europe shows paths which differ but which tended towards a certain convergence. A model strongly based on efficiency increase was followed categorically by the more advanced countries since the early 1960s and by the more backward countries of the southern periphery from the early 1980s. The countries of Central and Eastern Europe had to wait to perform their transition to market economies, to follow a similar model from the mid-1990s.

But what is there behind such an important role for efficiency improvement in European agriculture in the second half of the XX century? In great measure, this strong growth was derived from the massive adoption of technologies which permitted land and labour to be saved, while production increased or was maintained. Technology and technical progress, as we have seen, played a fundamental role in European agriculture throughout this period. Technological innovation materialized in a significant and growing use of capital inputs, which despite having been introduced before the Second World War in the most advanced countries, now spread to an unprecedented degree. The adoption of technological change and the conditions which permitted its generation, were without a doubt closely linked to the type of economy and society which developed in Europe following the Second World War (Gallego, 2007). In this way, high income economies, characterised by a continuous adoption of innovations oriented towards efficiency improvement, steered agriculture towards

a model of growth which was not significantly different from the general model of economic growth.

Perhaps the principal difference was the importance to agriculture of public policies oriented towards the maintenance of agricultural incomes, which considerably limited the role of the market. It is not that the public sector and government policies were not important in the remaining economic activities, but rather that in agriculture their role was much more decisive, due not only to the establishment of prices or the protection of the internal market, but also more dynamically, such as the boosts supplied by public research efforts. Research into creating and improving machinery, into chemical fertilisers and into the genetic selection of seeds to improve yields, among other research, meant a very strong boost to technical processes and, therefore, to TFP.

The countries with centrally planned economies departed from this model. Their strategy of a massive use of the capital factor in agriculture and a certain disdain for efficiency is congruent with their general model of economic growth. The countries of the southern European periphery, although they also initially based their agricultural growth on heavy injections of capital, attempted from a relatively early period to improve their efficiency, following (although with limitations) the model of agricultural development previously employed by the countries of Western Europe.

Yet this growth of TFP does not only show technical progress, but also a measurement of efficiency in the system as a whole. Its TFP growth was also based on an improvement in factor assignation (Federico 2011: 66).

We can say in conclusion that although our work validates the general hypothesis originally proposed by Federico (2005), on the eminently intensive agricultural growth in this period, the European case qualifies in two directions. Firstly, it highlights the close interconnection between TFP growth and use of modern capital inputs. Secondly, at the regional level in Europe it can be concluded that there were significant differences in the relative weights of their contribution to output growth of capital and TFP.

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Table 1. Net production (millions of US \$) (1999-2001 prices)

| | Pre-war | 1950 | 1962 | 1972 | 1982 | 1992 | 2000 | 2005 |
|---------------------------|---------|--------|---------|---------|---------|---------|---------|---------|
| GFR/Germany | 8,846 | 8,522 | 13,531 | 15,618 | 18,409 | 24,525 | 26,118 | 25,250 |
| GDR | n.a. | 3,762 | 4,236 | 5,853 | 6,835 | - | - | - |
| Western Europe | 30,763 | 33,497 | 47,003 | 56,264 | 68,242 | 73,098 | 73,571 | 70,966 |
| Mediterranean Eur. | 23,225 | 23,776 | 32,077 | 38,654 | 46,933 | 50,678 | 54,438 | 53,907 |
| Nordic Eur. | 3,604 | 4,050 | 4,443 | 4,529 | 5,220 | 4,732 | 4,858 | 4,897 |
| Central&Eastern E. | n.a. | 20,122 | 28,193 | 36,114 | 43,330 | 38,089 | 36,088 | 37,425 |
| France | 14,038 | 14,506 | 22,362 | 26,741 | 30,937 | 31,797 | 33,286 | 32,223 |
| United Kingdom | 5,929 | 7,213 | 9,163 | 10,985 | 13,527 | 14,294 | 13,535 | 13,082 |
| Italy | 12,086 | 13,033 | 17,229 | 20,027 | 23,663 | 23,771 | 23,761 | 23,450 |
| Spain | 7,253 | 6,564 | 9,197 | 12,049 | 15,540 | 17,877 | 21,242 | 21,503 |
| Poland | n.a. | 7,326 | 9,985 | 12,020 | 12,795 | 12,722 | 12,446 | 13,026 |
| European market economies | 64,407 | 69,844 | 97,055 | 115,065 | 138,804 | 153,032 | 158,985 | 155,019 |
| Europe | n.a. | 92,280 | 130,187 | 157,032 | 188,969 | 191,122 | 195,073 | 192,444 |

The data presented, except the pre-war level, are triennial averages based on the reference year. The GFR/Germany row displays data from the Federal Republic of Germany until 1992; from that year on the data are for reunified Germany. See the Appendix for the composition of the groups.

Source: Authors' elaboration, using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Table 2. Arable land and permanent crops (thousands of hectares)

| | 1950 | 1962 | 1972 | 1982 | 1992 | 2000 | 2005 |
|--------------------|-----------------------|---------|---------|---------|---------|---------|---------|
| GFR/Germany | 8,552 | 8,466 | 7,591 | 7,465 | 11,809 | 12,026 | 12,089 |
| GDR | 5,089 ⁽¹⁾ | 5,055 | 4,842 | 5,006 | - | - | - |
| Western Europe | 37,134 | 37,239 | 33,726 | 33,263 | 33,017 | 32,611 | 32,847 |
| Mediterranean Eur. | 43,303 ⁽²⁾ | 43,140 | 40,433 | 39,953 | 38,492 | 35,704 | 33,725 |
| Nordic Europe | 7,046 | 6,976 | 6,357 | 6,123 | 5,956 | 5,791 | 5,786 |
| Central&Eastern E. | 49,264 ⁽³⁾ | 50,978 | 49,801 | 48,528 | 47,104 | 45,181 | 42,294 |
| France | 21,187 | 21,322 | 18,674 | 18,989 | 19,297 | 19,561 | 19,608 |
| United Kingdom | 7,428 | 7,348 | 7,203 | 6,979 | 6,468 | 5,866 | 5,928 |
| Italy | 16,612 | 15,531 | 12,316 | 12,369 | 11,620 | 11,281 | 10,261 |
| Spain | 19,835 | 20,800 | 21,110 | 20,494 | 19,898 | 18,225 | 17,793 |
| Poland | 16,223 | 16,072 | 15,177 | 14,826 | 14,694 | 14,218 | 12,741 |
| Europe | 150,388 | 151,854 | 142,750 | 140,337 | 136,378 | 131,313 | 126,741 |

(1) Datum for 1949. Triennial average data, except 1950.

(2) Datum for Portugal from 1948.

(3) The datum for Albania is from 1943. Data for Hungary, Bulgaria and Romania from 1947. Datum for Czechoslovakia from 1948. Datum from Poland from 1955.

Source: Authors' elaboration, using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Table 3. Livestock units (thousands of units)

| | 1950 | 1962 | 1972 | 1982 | 1992 | 2000 | 2005 |
|--------------------|---------|---------|---------|---------|---------|---------|---------|
| GFR/Germany | 13,067 | 15,347 | 16,520 | 17,863 | 21,550 | 18,930 | 17,664 |
| GDR | 4,658 | 6,362 | 6,976 | 7,913 | - | - | - |
| Western Europe | 47,383 | 58,456 | 63,247 | 66,921 | 67,767 | 67,141 | 63,142 |
| Mediterranean Eur. | 23,511 | 26,350 | 25,605 | 27,102 | 28,181 | 28,949 | 29,229 |
| NordicEurope | 6,636 | 6,226 | 5,208 | 5,325 | 4,683 | 4,444 | 4,263 |
| Central&Eastern E. | 37,200 | 43,004 | 46,311 | 50,329 | 40,356 | 28,977 | 27,933 |
| France | 18,019 | 22,462 | 23,319 | 25,115 | 23,327 | 23,727 | 22,319 |
| UnitedKingdom | 11,654 | 15,024 | 16,913 | 15,757 | 17,002 | 16,219 | 15,123 |
| Italy | 11,235 | 11,502 | 11,480 | 11,629 | 11,229 | 9,960 | 9,568 |
| Spain | 7,881 | 9,164 | 8,778 | 9,828 | 11,855 | 13,826 | 14,560 |
| Poland | 10,428 | 13,954 | 16,391 | 15,712 | 12,479 | 9,562 | 9,883 |
| Europe | 132,456 | 155,744 | 163,866 | 175,453 | 162,536 | 148,442 | 142,230 |

Triennial average data, except 1950. Livestock units are the number of animals aggregated with the weightings of Hayami and Ruttan (1985). Consult the Appendix to see which animal species have been taken into account in the calculation of the variable.

Source: Authors' elaboration, using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Table 4. Kilograms of chemical fertilisers consumed per hectare

| | 1950 | 1962 | 1972 | 1982 | 1992 | 2000 | 2005 |
|------------------------|------|------|------|------|------|------|------|
| GFR/Germany | 161 | 295 | 427 | 425 | 240 | 233 | 211 |
| GDR | 159 | 202 | 340 | 305 | - | - | - |
| Western Europe | 83 | 164 | 299 | 333 | 287 | 253 | 235 |
| Mediterranean E. | 20 | 45 | 86 | 109 | 118 | 127 | 113 |
| Nordic Europe | 67 | 103 | 199 | 202 | 144 | 133 | 138 |
| Central and Eastern E. | 8* | 49 | 154 | 213 | 67 | 77 | 118 |
| France | 49 | 124 | 287 | 298 | 254 | 223 | 186 |
| United Kingdom | 111 | 195 | 257 | 356 | 322 | 320 | 282 |
| Italy | 29 | 56 | 119 | 165 | 167 | 145 | 123 |
| Spain | 11 | 36 | 68 | 70 | 88 | 122 | 107 |
| Poland | 11 | 58 | 204 | 224 | 82 | 110 | 186 |
| Europe | 47 | 97 | 192 | 226 | 153 | 151 | 156 |

Triennial average data, except 1950

* Data for fertilisers for Romania from 1949 and for Bulgaria from 1954. There are no data on fertilisers from Albania.

Source: Authors' elaboration using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Table 5. Tractors per worker

| | 1950 | 1962 | 1972 | 1982 | 1992 | 2000 | 2005 |
|--------------------|----------------------|-------|-------|-------|-------|-------|-------|
| GFR/Germany | 0.027 | 0.289 | 0.716 | 0.983 | 0.950 | 0.976 | 1.153 |
| GDR | 0.006 ⁽¹⁾ | 0.071 | 0.137 | 0.164 | - | - | - |
| Western Europe | 0.045 | 0.238 | 0.502 | 0.789 | 0.974 | 1.146 | 1.259 |
| MediterraneanEur. | 0.005 | 0.032 | 0.115 | 0.264 | 0.484 | 0.732 | 0.926 |
| NordicEurope | 0.046 | 0.253 | 0.496 | 0.788 | 1.015 | 1.191 | 1.378 |
| Central&Eastern E. | 0.003 ⁽²⁾ | 0.014 | 0.036 | 0.109 | 0.188 | 0.262 | 0.332 |
| France | 0.019 | 0.195 | 0.467 | 0.801 | 1.115 | 1.440 | 1.631 |
| UnitedKingdom | 0.268 | 0.500 | 0.638 | 0.744 | 0.825 | 0.948 | 0.999 |
| Italy | 0.007 | 0.052 | 0.185 | 0.430 | 0.778 | 1.320 | 1.816 |
| Spain | 0.003 | 0.020 | 0.088 | 0.231 | 0.439 | 0.682 | 0.824 |
| Poland | 0.002 | 0.012 | 0.043 | 0.136 | 0.250 | 0.347 | 0.422 |
| Europe | 0.014 | 0.073 | 0.159 | 0.294 | 0.436 | 0.568 | 0.690 |

Triennial average data, except 1950

(1) The datum for tractors is an average between 1949 and 1952.

(2) Data for tractors in Hungary from 1951. Data are not available for Albania.

Source: Authors' elaboration using data from FAO (1948-2004) and FAOSTAT (2009). For more details, see the Appendix.

Table 6. Active population in agriculture (thousands)

| | 1950 | 1962 | 1972 | 1982 | 1992 | 2000 | 2005 |
|--------------------|-----------------------|--------|--------|--------|--------|--------|--------|
| GFR/Germany | 5,114 | 3,466 | 1,965 | 1,497 | 1,446 | 1,014 | 820 |
| GDR | 2,378 ⁽¹⁾ | 1,411 | 1,064 | 916 | - | - | - |
| Western Europe | 12,357 ⁽²⁾ | 7,532 | 5,228 | 3,889 | 3,047 | 2,402 | 2,109 |
| MediterraneanEur. | 16,468 ⁽³⁾ | 13,691 | 9,734 | 7,454 | 5,345 | 4,071 | 3,548 |
| NordicEurope | 1,904 | 1,229 | 895 | 705 | 515 | 398 | 343 |
| Central&Eastern E. | 29,079 ⁽⁴⁾ | 27,262 | 22,239 | 15,958 | 11,790 | 8,877 | 7,397 |
| France | 7,480 | 4,139 | 2,792 | 1,863 | 1,244 | 880 | 723 |
| UnitedKingdom | 1,215 | 935 | 728 | 702 | 607 | 528 | 500 |
| Italy | 8,261 | 5,937 | 3,779 | 2,652 | 1,870 | 1,255 | 1,029 |
| Spain | 4,853 | 4,616 | 3,505 | 2,471 | 1,746 | 1,326 | 1,193 |
| Poland | 7,090 | 6,923 | 6,508 | 5,245 | 4,684 | 3,766 | 3,351 |
| Europe | 67,300 | 54,592 | 41,125 | 30,418 | 22,143 | 16,762 | 14,218 |

Triennial average data, except 1950

(1) Datum for 1946.

(2) Data from France for 1946. Data from Belgium, Luxembourg and the Netherlands for 1947. Data from the UK, Austria and Ireland for 1951.

(3) Data from Italy and Greece for 1951.

(4) Data from Bulgaria and Czechoslovakia for 1946. Data from Yugoslavia for 1948 and from Hungary for 1949. Data from Romania for 1956.

Source: Authors' elaboration using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Table 7. Annual growth rates of outputs, inputs and TFP between 1950 and 2005

| | Output growth | Agri. Labour growth | Human Capital growth | Land growth | Capital growth | TFP |
|------------------------|---------------|---------------------|----------------------|-------------|----------------|------|
| Austria | 1.35 | -3.35 | 1.18 | -0.44 | 3.37 | 1.41 |
| Belgium-Lux | 1.44 | -3.18 | 0.91 | -0.34 | 2.75 | 1.67 |
| Denmark | 1.18 | -3.13 | 0.07 | -0.27 | 2.13 | 1.83 |
| France | 1.48 | -3.87 | 1.00 | -0.14 | 2.43 | 1.94 |
| Ireland | 1.47 | -2.09 | 0.83 | -0.18 | 2.52 | 1.33 |
| Netherlands | 1.84 | -1.87 | 1.09 | -0.11 | 1.84 | 1.68 |
| Switzerland | 0.63 | -1.53 | 0.44 | -0.23 | 1.22 | 0.79 |
| UK | 1.06 | -1.64 | 0.83 | -0.41 | 1.04 | 1.23 |
| Western E. | 1.37 | -2.98 | 0.87 | -0.22 | 1.95 | 1.71 |
| Greece | 2.07 | -1.16 | 0.58 | 0.13 | 3.16 | 1.40 |
| Italy | 0.89 | -3.78 | 0.41 | -0.87 | 3.08 | 1.63 |
| Portugal | 0.90 | -1.73 | 1.04 | -1.09 | 2.21 | 0.97 |
| Spain | 2.34 | -2.52 | 1.19 | -0.20 | 3.64 | 1.93 |
| Mediterranean E. | 1.48 | -2.74 | 0.77 | -0.46 | 3.05 | 1.56 |
| Finland | 0.87 | -3.66 | 0.98 | -0.18 | 3.18 | 1.07 |
| Norway | 0.42 | -2.36 | 0.81 | 0.12 | 2.20 | 0.35 |
| Sweden | -0.01 | -2.85 | 0.65 | -0.61 | 1.31 | 0.67 |
| Nordic E. | 0.32 | -3.07 | 0.80 | -0.36 | 1.88 | 0.78 |
| Albania | 2.60 | 0.37 | 0.60 | 0.81 | 2.33 | 1.33 |
| Bulgaria | 0.50 | -5.01 | 0.77 | -0.45 | 0.14 | 2.18 |
| Czechoslovakia | 0.30 | -2.38 | 1.44 | -0.28 | 1.47 | 0.36 |
| Hungary | 0.99 | -3.10 | 1.53 | -0.34 | 2.81 | 0.94 |
| Poland | 0.63 | -1.35 | 0.53 | -0.44 | 3.10 | 0.27 |
| Romania | 1.99 | -3.44 | 1.51 | -0.02 | 2.89 | 1.94 |
| Yugoslavia | 1.72 | -3.35 | 0.57 | -0.32 | 4.29 | 1.71 |
| Central and Eastern E. | 0.97 | -2.65 | 0.92 | -0.30 | 3.04 | 0.91 |
| Europe | 1.27 | -2.76 | 0.87 | -0.31 | 2.17 | 1.50 |

*The growth rates reference to the period 1962-2005 because of there are not data for Albania in the 1950s.

Triennial averages have been used, centred on the reference year, for the calculation of all growth rates, except for the variables of active population, arable land and tractors for the year 1950 and for livestock units for Spain and Portugal in the year 1950. When taking into account the data for 1950 and 2005 for the calculation of TFP, this cannot be calculated for Germany, because in 1950 we have data available for the two Germanys, while in 2005 these come from the reunified Germany.

Source: Authors' elaboration using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Table 8. Annual growth rate of output, inputs and TFP between 1950 and 1985

| | Output growth | Agri. Labour growth | Human Capital growth | Land growth | Capital growth | TFP |
|------------------------|---------------|---------------------|----------------------|-------------|----------------|------|
| GDR | 1.88 | -2.63 | 0.26 | -0.07 | 2.83 | 2.02 |
| GFR | 2.35 | -3.90 | 0.52 | -0.39 | 2.72 | 3.00 |
| Austria | 2.07 | -3.70 | 1.31 | -0.56 | 5.22 | 1.76 |
| Belgium-Lux | 1.86 | -3.60 | 1.12 | -1.03 | 4.55 | 1.93 |
| Denmark | 1.49 | -3.08 | 0.11 | -0.09 | 4.10 | 1.52 |
| France | 2.29 | -3.72 | 0.93 | -0.28 | 4.08 | 2.32 |
| Ireland | 2.12 | -2.51 | 1.16 | -0.68 | 3.82 | 1.85 |
| Netherlands | 2.93 | -2.36 | 1.47 | -0.60 | 3.17 | 2.63 |
| Switzerland | 1.21 | -1.74 | 0.71 | -0.49 | 2.53 | 1.09 |
| UK | 1.85 | -1.73 | 0.98 | -0.16 | 1.81 | 1.70 |
| Western E. | 2.14 | -3.14 | 0.97 | -0.28 | 3.26 | 2.17 |
| Greece | 3.02 | -0.62 | 0.54 | 0.36 | 5.02 | 1.58 |
| Italy | 1.32 | -3.53 | 0.45 | -0.89 | 5.11 | 1.41 |
| Portugal | 0.87 | -1.20 | 1.27 | -0.33 | 3.32 | 0.08 |
| Spain | 2.92 | -2.20 | 1.12 | 0.09 | 5.00 | 1.95 |
| Mediterranean E. | 1.94 | -2.48 | 0.76 | -0.26 | 4.57 | 1.45 |
| Finland | 1.56 | -3.50 | 1.18 | -0.24 | 5.57 | 1.02 |
| Norway | 0.79 | -2.34 | 0.91 | 0.16 | 3.45 | 0.33 |
| Sweden | 0.35 | -2.76 | 0.78 | -0.71 | 2.20 | 0.75 |
| Nordic E. | 0.77 | -2.99 | 0.93 | -0.43 | 3.19 | 0.84 |
| Albania | 3.42 | 1.87 | 0.80 | 1.67 | 5.56 | 0.34 |
| Bulgaria | 2.59 | -3.70 | 0.90 | -0.15 | 3.99 | 2.61 |
| Czechoslovakia | 1.44 | -2.17 | 1.77 | -0.18 | 3.83 | 0.63 |
| Hungary | 2.30 | -2.76 | 1.69 | -0.25 | 5.33 | 1.37 |
| Poland | 1.62 | -0.87 | 0.67 | -0.25 | 5.95 | 0.20 |
| Romania | 3.62 | -2.67 | 2.03 | 0.30 | 6.08 | 2.12 |
| Yugoslavia | 3.12 | -2.24 | 0.69 | -0.01 | 7.50 | 1.69 |
| Central and Eastern E. | 2.23 | -2.08 | 1.33 | -0.08 | 5.91 | 0.96 |
| Europe | 2.09 | -2.41 | 0.91 | -0.20 | 3.88 | 1.68 |

*The growth rates reference to the period 1962-1985 because of there are not data for Albania in the 1950s.

Triennial averages have been used, centred on the reference year, for the calculation of the growth rates, except for the variables of active population, arable land and tractors for the year 1950 and for livestock units for Spain and Portugal in the year 1950.

Source: Authors' elaboration using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Table 9. Annual growth rates of output, inputs and TFP between 1985 and 2005

| | Output growth | Agri. Labour growth | Human Capital growth | Land growth | Capital growth | TFP |
|------------------------|---------------|---------------------|----------------------|-------------|----------------|-------|
| Germany | -0.41 | -4.60 | 1.79 | -0.14 | -1.93 | 1.18 |
| Austria | 0.09 | -2.72 | 0.94 | -0.23 | 0.25 | 0.76 |
| Belgium-Lux | 0.73 | -2.44 | 0.54 | 0.89 | -0.30 | 1.18 |
| Denmark | 0.63 | -3.20 | -0.01 | -0.59 | -1.21 | 2.35 |
| France | 0.10 | -4.14 | 1.13 | 0.10 | -0.36 | 1.26 |
| Ireland | 0.35 | -1.35 | 0.26 | 0.70 | 0.34 | 0.40 |
| Netherlands | -0.03 | -1.01 | 0.42 | 0.75 | -0.44 | 0.03 |
| Switzerland | -0.38 | -1.15 | -0.03 | 0.23 | -1.01 | 0.24 |
| UK | -0.30 | -1.48 | 0.58 | -0.84 | -0.26 | 0.41 |
| Western E. | 0.03 | -2.70 | 0.69 | -0.12 | -0.30 | 0.89 |
| Greece | 0.43 | -2.11 | 0.64 | -0.26 | 0.06 | 1.05 |
| Italy | 0.14 | -4.23 | 0.34 | -0.84 | -0.30 | 1.96 |
| Portugal | 0.96 | -2.64 | 0.63 | -2.41 | 0.30 | 2.50 |
| Spain | 1.33 | -3.08 | 1.32 | -0.69 | 1.33 | 1.88 |
| Mediterranean E. | 0.67 | -3.21 | 0.78 | -0.81 | 0.48 | 1.73 |
| Finland | -0.33 | -3.96 | 0.62 | -0.07 | -0.84 | 1.14 |
| Norway | -0.24 | -2.39 | 0.63 | 0.04 | 0.08 | 0.37 |
| Sweden | -0.65 | -3.00 | 0.41 | -0.44 | -0.23 | 0.53 |
| Nordic E. | -0.47 | -3.20 | 0.58 | -0.23 | -0.37 | 0.68 |
| Albania | 1.67 | -1.33 | 0.36 | -0.18 | -1.18 | 2.40 |
| Bulgaria | -3.05 | -7.27 | 0.55 | -0.97 | -6.22 | 1.42 |
| Czechoslovakia | -1.65 | -2.74 | 0.86 | -0.46 | -2.47 | -0.14 |
| Hungary | -1.26 | -3.69 | 1.26 | -0.48 | -1.23 | 0.14 |
| Poland | -1.07 | -2.19 | 0.30 | -0.76 | -1.68 | 0.35 |
| Romania | -0.79 | -4.77 | 0.61 | -0.60 | -2.42 | 1.60 |
| Yugoslavia | -0.69 | -5.26 | 0.35 | -0.86 | -0.95 | 1.68 |
| Central and Eastern E. | -1.19 | -3.64 | 0.20 | -0.69 | -1.78 | 0.80 |
| Europe | -0.15 | -3.37 | 0.81 | -0.50 | -0.76 | 1.18 |

Triennial averages, centred on the reference year, have been used for the calculation of the growth rates. Data for Czechoslovakia and Yugoslavia were aggregated following their dissolution.

Source: Authors' elaboration, using data from FAO (1948-2004) and FAOSTAT (2009). For details, see the Appendix.

Appendix

Groups of countries: The countries which constitute the Western Europe group are: Austria, Belgium-Luxembourg, Denmark, France, Ireland, the Netherlands, Switzerland, and the United Kingdom. The countries included in the Mediterranean group are: Greece, Italy Portugal and Spain. Three countries comprise the Nordic group: Finland, Norway and Sweden. The last and final group, Central and Eastern Europe, is formed by Albania, Bulgaria, Czechoslovakia, Hungary, Poland, Rumania and Yugoslavia.

Data sources for the tables: Authors' elaboration, using as a base FAOSTAT (2009). The 1950 datum for all the variables has been elaborated using FAO (1948-2004). Data from the two Germanys prior to 1992, authors' elaboration based on FAO (1948-2004).

Calculation of variables:

Production: The data are for net production, which is gross production minus seed and replacements.

The data have been extracted from FAOSTAT (2009) and FAO (1948-2004) in the following way. The data from 1962 to 2005 were downloaded from FAOSTAT (2009). These represent the level of net production at 1999-2001 prices in international dollars. The only exception to this procedure was the case of Germany. The data corresponding to the Federal Republic of Germany and to the German Democratic Republic have been calculated using the 1999-2001 prices from Germany, downloaded from FAOSTAT (2009), multiplied by the physical productions, extracted from FAO (1948-2004). Prior to 1961 FAOSTAT does not offer production data, but the annals of FAO (1948-2004) do however facilitate numerous indices of gross production from 1948, with a base firstly in the pre-war level and later in 1953. To obtain a complete annual series from 1948, we have employed the evolution of those numbers indicating indices gross production, comparing the 1961 value of net production with the index number of the same year. Obviously, we are assuming that the evolution of gross production and net production are equivalent. In this way we calculate net production until 1953. Prior to that year the base level in the numerous indices calculated by FAO is the pre-war level. Thus, we calculate the evolution between 1948 and 1953 by comparing the production level obtained in 1953 with the index number of the same year with its base in the pre-war level.

Agricultural workers: The population censuses do not permit us to establish the number of part-time workers in agriculture, when they are not registered in this activity. In the same way it is not possible to determine whether the workers registered in the sector dedicate all their time to this activity. Consequently, it would be convenient to measure the active agricultural population in hours worked (Federico 2005 and 2011). Faced with the difficulty of finding reliable databases for broad spatial and temporal samples of this variable, we decided to observe the active population in agriculture by the number of workers. This variable, although it differs from the true labour force, can describe in broad outlines the sharp decrease in the real human labour force which agriculture suffered following the second post-war period.

Human capital: We use a human capital measure based in educational attainment. To calculate our human capital measurement we follow these steps. We obtain the data from WDI (2011). The first datum that WDI offers is 1960. To obtain the data for 1950, we have supposed that the Barro-Lee's years of schooling has followed the same evolution that the Gross Enrolment Ratio. Once obtained the years of schooling in the second half of the twentieth, we have to calculate one measure of human capital. Prados and Roses (2010) used several human capital measures to calculate the human capital in Spain. One of these variables is based in Bosworth and Collins (2003): $HC_{EC} = (1 + r)^{schooling}$, where r is the rate of return. The rates of return for each country are obtained from Pscharopoulos and Patrinos (2004). For the country in which there are several rates of return, we calculate the average rate of return. In the case of one country do not have any rate of return, we assign the rate of return corresponding to its level of income per capita.

Livestock units: This is a weighted average in which the weightings are obtained from Hayami and Ruttan (1985), and the species taken into account, together with the weightings in parentheses, are: donkeys or asses (0.8), buffalos (1), horses (1), goats (0.1), pigs (0.2), chickens (0.01), beef cattle (0.8), geese (0.01), mules (1), sheep (0.1), ducks (0.01) and turkeys (0.01).