Changes in the use of production services in agriculture in the context of meeting the targets for sustainable agricultural development

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Abstract: The essence of sustainable agriculture is to orchestrate production, social and environmental objectives. The pursuit of sustainable agricultural development requires the use of optimum manufacturing processes, which should be cost-effective and environmentally-friendly. To do so, it is useful, if not necessary, to supplement a farm's production potential. The use of production services is an alternative to investing in technical farming equipment or to purchasing some productive inputs. It is therefore worth considering how, and to what extent, production services in agriculture may support the pursuit of sustainable manufacturing processes. The aim of this paper is to present the changes in the use of selected production services in agriculture against the background of the concept of sustainable agriculture. Also, this paper attempts to answer the question of the role of services in pursuit of sustainability in the agriculture sector. The following was considered: the relationships between production services and the implementability of the sustainable agriculture model; and the level of (and changes to) the use of these services in EU countries demonstrating different levels of economic development, different natural conditions and different agricultural production patterns. The analysis was based on a deductive method and correlation analysis. The study was based on relevant literature and statistical data. The average use of production services is greater in the agriculture of EU-15 than in EU-10 countries. This suggests a relationship between economic development levels (including agricultural ones) and the use of production services. In EU-15 countries, there is evident correlation between the use of services and fixed capital formation. In the EU-10, that correlation is weaker for agricultural services, but tends to be stronger for veterinary services. The use of production services may support the pursuit of sustainable agricultural development, provided that farm managers take sustainability into consideration in their decisions.

Keywords: production services, sustainable development, sustainable agriculture

JEL: Q16, Q19

Introduction

In the broad context of economic transformation affecting national and international economies, the sustainable development paradigm becomes particularly important for agriculture. According to Pawlak [2008, p. 13] the essence of sustainable agriculture *is to orchestrate production, social and environmental objectives.* From that perspective, it is of key importance to ensure the implementation of optimum manufacturing processes which should

be cost-effective and environmentally-friendly[1]. To do so, it is useful, if not necessary, to supplement a farm's production potential. The use of production services is an alternative to investing in technical farming equipment or to purchasing some productive inputs. It is therefore worth considering how, and to what extent, production services in agriculture may support the pursuit of sustainable manufacturing processes. To answer that question, the following was considered: the relationships between production services and the implementability of the sustainable agriculture model; and the level of (and changes to) the use of these services in EU countries demonstrating different levels of economic development, different natural conditions and different agricultural production patterns. This is an important issue, because in the domestic and foreign literature on services there are almost exclusively theoretical and empirical analyses of a general nature, not referring to such a specific sector of the national economy as agriculture.

Methods and materials of the study

The aim of this paper is to present the changes in the use of production services in plant and animal production against the background of the sustainable agriculture concept. Also, this paper attempts to answer the question on the role of services in the pursuit of sustainability in the agriculture sector. For this reason, the article consists of two parts: the first one is a theoretical discussion, and the other one covers empirical analysis.

The empirical part of this paper presents quantitative characteristics of production services used in agriculture in specific member countries of the European Union. Two groups of services used in plant and animal production were selected for this study: agricultural services (for third parties) and veterinary expenses, as defined in EU legislation (*Regulation (EC)* No. 138/2004):

– agricultural services constitute the hire of machines and equipment with the

[1] Based on the *Our Common Future* report, Zegar (eds., 2013, p. 9) states that: *the requirement for implementing the idea of sustainable development is a certain level of economic development which, in the case of most countries around the world, also means economic growth. This is necessary in order to improve the quality of living and economic well-being which, in turn, raise awareness and increase public pressure on environmental issues. However, as a critical element of the sustainable development concept, economic growth cannot go beyond the potential of the global ecosystem (biosphere). To this end, having in mind demographic trends, three lines of action need to be pursued simultaneously. The first and the most important one is to intensify the creation and use of innovations, especially including technologies for more efficient use of available natural resources. The second one means measures taken to rationalise per capita consumption as regards both consumption levels in wealthy societies and the level of total capital: human capital and natural capital (assuming the two kinds of capital are substitutable by each other to a virtually unlimited extent). According to the requirements of the strong sustainability concept, each of the two kinds of capital (economic and natural) must be preserved separately (as they are not fully interchangeable). Also, critical natural capital (ecosystems and natural assets necessary in order to sustain the vitality and the patterns of consumption) must be preserved. The third line of action is represented by measures taken to reduce losses and wastage throughout the product's lifecycle.*

corresponding labour (*services for third parties — e.g. the renting and repair of agricultural machinery, irrigation projects, agricultural advisory services, product storage, maintenance of farm buildings, commercial services relating to agricultural products, transport of agricultural products, etc. These services are recorded as secondary activities, only if they are performed for a third party. When performed for own account, they are ancillary activities, which are not recorded in the accounts*). Due to the availability of data in the EUROSTAT database, only agricultural services related to plant production (which constitute the hire of machines and equipment with the corresponding labour) are included in the empirical part of the article;

- *veterinary expenses – medicines which are invoiced separately from the veterinary surgeon's fee should be recorded here (medicines administered directly by the veterinary surgeon are recorded with his fee and veterinary costs).*

The analysis was based on a deductive method and correlation analysis[2]. The study was based on data delivered by EUROSTAT, the Statistical Office of the European Union, and on relevant literature. The territory covered by this study are European Union countries. The period covered is 2000-2016. The starting point of the analysis was chosen to take into account the situation before the enlargement of the EU, while the last available data from EUROSTAT resources is related to 2016.

Theoretical background and discussion

The essence of production services used in agriculture

The definition of production services came later than the services themselves. The relevant terms were formalised because of the need to describe the reality for the purposes of farming activities and academic research. Another reason was the need to retrieve information for planning purposes. Several positive[3] definitions exist of production services in agriculture. Rogoziński [2000, p. 60] defined production services as *cooperation activities in the production process (...) which consist in increasing the use value of goods manufactured by undertakings, or in facilitating a production process*[4]. In the case of production services in agriculture, an operator external to the farm considered must be involved in the production process. Note also that the criterion of participation in production processes does not necessarily mean the physical involvement of the service concerned. The service only needs to contribute

[2] These are commonly known methods, so they do not require detailed description.
[3] Positive definitions identify services based on their characteristics which refer to addressing the needs of humans or production processes, usually by performing an act. A negative definition is based on negation; it specifies what a service is not, and states that if the negative conditions are not met, the act in question is a service.
[4] See: Ilnicki (2009, p. 40).

to the final result (i.e. the product). Therefore, production services in agriculture include agricultural services related to soil cultivation, veterinary services, maintenance of machinery and equipment used in production, financial services (if related to production) and consultancy services (if affecting production outcomes). Obviously, the above is a non-exhaustive list.

Sustainable development and sustainable agriculture

In the 1970s and 1980s, the progressing industrialisation of agricultural production disrupted the natural harmony between agriculture and the natural environment. The industrial agricultural model was dominated by economic aspects which inevitably led to an increase in the efficiency and intensity of agricultural production. This, in turn, resulted in soil degradation, increased environmental pollution and degradation of ecosystem biodiversity. The development of sustainable agriculture was a concept built to address the threats entailed by those adverse events [Kalinowski 2013, p. 113]. It was a part (and essentially a further detailing) of a broader definition of sustainable development with respect to social, economic and environmental aspects [Zegar 2007, p. 297]. B. Czyżewski [2012, p. 168] states that the essence of sustainable development is a Pareto-efficient progress. This means that monetised productivity needs to be aligned with the progressive implementation of environmental and social objectives. However, in this case, the necessary condition is to restructure the basket of *utility sold by producers* in order to take better account of environmental and social aspects. The improved quality of food and non-agricultural services (e.g. leisure or supply of renewable energy) may become new values which partially offset or supplement the drop in farming incomes caused by the need to incur environmental protection costs[5].

The objectives sought by agriculture are related not only to food production (the productive function) but also to new functions of agriculture and to rural development (non-productive functions) laying the grounds for multifunctional sustainable development, i.e. a process that takes economic, social and environmental criteria into account [Zegar 2005, p. 8, Wilkin 2010, p. 11-15, Kowalczyk and Sobiecki 2011, p. 35]. As the sustainable development paradigm is now widely adopted, that fact is becoming increasingly recognised. The concepts of the sustainability and multifunctionality of rural areas lie at the core of the CAP [Kulawik 2015, s. 48]. This is why financing is provided under the CAP for measures related to agricultural services delivery[6]. Another factor that drives the use of services is farm

[5] In this case, preventive measures taken by the government (which consist in imposing specific requirements and promoting the awareness of sustainable development) must be accompanied by a grass-roots process redefining the needs of consumers (B. Czyżewski 2012, p. 169).

[6] In 2007-2013, as a part of axis 3 on the "quality of life in rural areas and diversification of the rural economy,"

modernisation and increased technical potential, which largely results from aid disbursed under the CAP. Generally, although some forms of financing (e.g. area payments) are criticised, each of them contributes to increasing the amount of funds available to the farmers. This is why raising the awareness of farmers is just as important as the payments themselves, so that their decisions regarding allocation of funds are consistent with the sustainable agriculture concept and the European agricultural model[7].

How do production services in agriculture support the evolution towards sustainable agriculture?

Agricultural production is the result of three factors of production: labour, land and capital, which may be substituted[8] for each other within certain limits. Components of a specific factor of production may also be substituted for each other, as illustrated by the example of services used instead of the farmers' own agricultural equipment. Generally, a farm may attain a specific production result using various combinations of factors of production and of their components; the combination is determined by the prices of inputs concerned, resulting from the abundance of relevant factors of production and their components. A situation defined by large resources of labour and a deficiency of capital will be conducive to increased use of the abundantly available factor of production (labour). In this case, capital expenditure (including purchase of services) will be smaller, often limited to measures increasing the productivity of land. Because the agricultural goods output must continue to grow, the reduction

two measures were implemented to support the creation and development of non-agricultural activities (including services for farms): measure 3.1.1 "Diversification into non-agricultural activities" and measure 3.1.2 "Formation and development of micro-enterprises". In the 2014-2020 Financial Perspective, measure 8.2.6 (M06) "Development of farms and economic activity" includes measure 8.2.6.3.5 "Development of entrepreneurship – development of agricultural services" with a sub-measure "Support for investments in the creation and development of non-agricultural activities" which enables applying for funds to support investments in activities consisting in the delivery of agricultural services. Support will be allocated to operations which contribute the most to improving the availability of state-of-the-art agricultural services offered to small farms, and to implementing the EU's horizontal priorities. Therefore, preferential procedures were put in place for operations which contribute to implementing the European Union's priorities:

- innovativeness, by launching new services or changing the technology of services offered with the use of new machinery and equipment that has so far not been used by the service provider concerned;
- combating climate change, by delivering the services with the use of technologies, machines, devices and equipment which reduce the environmental impact; the organisation of service delivery needs to be based on low-carbon solutions that improve resource, energy and water efficiencies.

Aid shall be granted to operators who did not access support under either of the following measures: "Diversification into non-agricultural activities" or "Formation and development of micro-enterprises" covered by the 2007-2013 RDP. The investments shall be implemented in districts with highly fragmented structure of agricultural land (*Rural Development Program 2014-2020* 2014, p. 145-146).

[7] As pointed out by many authors, including A. Czyżewski (2013a, p. 835), an alternative path for agricultural development is not appropriate to reach the economic, social and environmental objectives in the long run.

[8] In addition to the above factors of production, entrepreneurship or human capital are cited in some sources (e.g. Marks-Bielska and Babuchowska 2015, p. 9).

of the farms' labour resources and the increase in costs thereof result in the growing importance of capital expenditure, especially if it enables an increase in labour productivity, e.g. by providing the employees with agricultural machinery and equipment. In turn, the increased availability of fixed assets drives increased demand for production services related to the creation, use and employment of such assets for production purposes (e.g. repair and maintenance services)[9]. At the same time, if capital expenditure is partially allocated to services rather than to the farm's own assets, it may reduce the production costs (and make them more flexible because of the reduction in fixed costs related to the purchase, ownership and use of own machinery and equipment). This is in line with the objective of seeking economies of scale in production processes and improving the economic outcomes of farming[10].

The pursuit of sustainable agricultural production, as an essential part of the broader process of developing a sustainable agriculture, requires the optimisation of production processes as regards both economic efficiency and compliance with social and environmental objectives. Production services may considerably contribute to that optimisation.

Since the very beginning, agricultural manufacturing processes have been a driver of technical progress, have contributed to a general increase of awareness among agricultural producers, and have played a major role in regulating farming incomes, thus improving the living and working conditions of the rural population[11]. The income-generating function of services is important for the stimulation of consumption and agricultural development, both of which depend not only on the levels of internal accumulation of capital and labour productivity in agriculture, but also on total national income. The resources of state-of-the-art productive inputs and manufacturing techniques delivered to farms through production services have led, and continue to lead, to the rationalisation of the mix of productive inputs and production growth drivers and, as a consequence, to an increase in business income and in the accumulation fund which is mostly allocated to investments stimulating the growth of farms' production potential. If appropriate technological regimes are adhered to, the above resources may also contribute to improving the quality of food production and to reducing the adverse environmental impacts of production processes. By offering jobs to members of farming families, the developing service sector becomes an alternative source of income. Also, as it takes over a part of the underutilised farming labour force, it determines the productivity growth

[9] This reflects the complementarity of inputs which also becomes apparent in a situation where the growing consumption of fertilisers and plant protection products (aimed at improving land productivity) boosts the demand for related work (whether performed internally or contracted).
[10] Cf. Cieśla, Kowalska-Grudzień and Kruczek-Patko (1987, p. 92-93).
[11] When used creatively, knowledge resources do not only contribute to social and economic development but are also a way to enhance competitiveness (Firlej and Żmija 2014, p. 9).

of other farm employees. With their income-generating function, production services do not just promote an increase in farms' economic strength and an improvement of the farming population's living conditions. They also drive the farmers' interest in joint projects and accelerate the horizontal integration of agriculture, enabling collective price negotiations and the shared use of technical productive inputs. Furthermore, they stimulate the release of excessive labour from the agricultural sector. The resulting benefits include reduced unit production costs and increased personal incomes. The technical and organisational progress allows the farms to upgrade their existing production facilities, eliminates hard work in harmful conditions and makes working more comfortable. By changing the nature of work and enhancing the attractiveness of the farming profession, it streamlines the structure of agricultural employment by age and education[12]. Also, it contributes to reducing the environmental impact of production processes.

Therefore, it will be more difficult to meet the sustainable agriculture requirements if the farms fail to tap into the potential and knowledge of service providers. First of all, in the long run, it is neither reasonable nor economically viable to continue using the resources of agricultural machines mostly composed of obsolete, end-of-life equipment. This is especially true if the service delivered with the use of newer, more powerful equipment is not only cheaper but also drives better production, environmental and social outcomes. Secondly, while improving the quality of a farm's own machinery (e.g. by purchasing newer, more powerful tractors and agricultural machines) and of other fixed assets (e.g. livestock buildings and related equipment) is a way to reduce the use of direct production services, it requires assistance from providers of other services (for instance, when it comes to servicing technically sophisticated machinery and equipment). Thirdly, the need to comply with technological production regimes makes it necessary to seek assistance from specialised service providers (e.g. veterinary or maintenance services). Fourthly, because of the service providers' knowledge and potential, services (including consultancy) often drive innovations which translate into environmental, economic and technological benefits.

Changing the mindset[13] is the first step required in shifting from industrial

[12] Cf. Wojciechowska (1979, p. 32-33).

[13] Legiędź (2012, p. 41) states that (…) *the markets are imperfect, trade information is incomplete, transaction costs are considerable, and market players are guided by their subjective mindsets formed by historical developments and existing ideologies. Therefore, just as it often happens in real life, the selected development path may remain ineffective in the longer term. The operators may shift to another path only if they change their perceptions as a result of a slow evolution of formal and informal principles.* The above is consistent with Hayek's opinion (1948, p. 90) on the role of non-economic drivers of human behaviour affecting allocation decisions. Cf. Siebenhüner (2000, p. 15-25), Kiełczewski (2016, p. 269-276). The evolution of the abovementioned formal and informal principles is manifested not only at institutional and economic level but also (if not primarily) by a shift

to sustainable[14] agricultural processes. After that, adequate legal regulations must be adopted and an implementation framework must be established. The next step is to take measures which have not yet been applied, or to promote wide adoption of measures taken so far by only a few farms. To do so, sources of funding must be found to finance the changes. Then, measures need to be taken to comply with the requirements of the sustainable agriculture concept. At macro level, this requires political and systemic actions, whereas the key aspect for farms is their adaptability to the new operational concept and their technical capacities. This is where services become helpful, if not essential (because of farms' limited potential). It can therefore be concluded that services provide help for any kind of agricultural production and are an integral, often essential part of sustainable agriculture[15].

The results of empirical research and discussion

The use of services grows in line with economic development; this pattern is definitely true in the long term (at least several decades) [Kołodziejczak 2016, p. 192]. However, over a shorter time scale, it may be subject to fluctuations. Therefore, data collected over a period of several or ten to twenty years does not warrant the conclusion that a causative link exists between the two aspects. However, specific countries and country groups may be compared to each other in an attempt to find a pattern. Such groups may be created by aggregating the "old" and "new" EU countries, i.e. by extracting the UE-15 and UE-10 aggregates from the EU-25. Figure 1 shows the evolution of average values of agricultural services and veterinary expenses over the 2000-2016 period in the groups considered, per hectare of agricultural land and per AWU[16] (or per EUR 1,000 worth of agricultural goods output in Figure 2). First of all, note that the values presented in Figure 1 are considerably lower for EU-10 countries[17].

Despite the relatively short period, a growth in the value of services is also noticeable,

in human attitudes. This is related to the market players' evolution from *homo oeconomicus* to *homo sustinens*, as described by Kraciuk (2015, p. 211-219).

[14] For a broader description, see A. Czyżewski (2013b, p. 1-24).

[15] A. Czyżewski (2013a, p. 834) states that *the shift from industrial to sustainable agriculture is inevitable in the long term. Today, it becomes necessary to set up ethical and social barriers that restrict the development of industrial agriculture. As the sustainable development paradigm becomes widely adopted and as the supply becomes constrained, it will be easier to overcome the barriers to demand for food. Obviously, the demand will remain rigid and restricted, and its income elasticity will remain low. Nevertheless, the agricultural adaptation mechanism will put a stronger focus on the allocation of productive inputs in line with the requirements of environmental welfare (...). However, there may be various forms of sustainable agriculture because its productive function will be combined with the following aspects: multifunctionality of family-owned farms; organic production processes; promoting a living countryside; improving the quality of food; or symbiosis with the natural environment.*

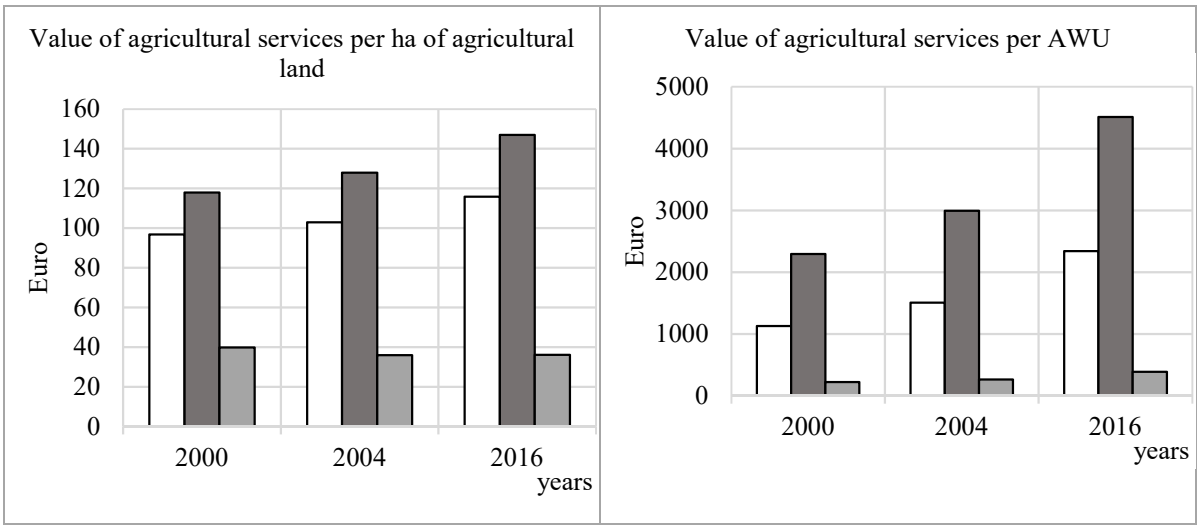
[16] AWU (Annual Work Unit) means the total amount of own and hired labour, i.e. 2,120 hours of work within a year (265 working days, 8 hours each).

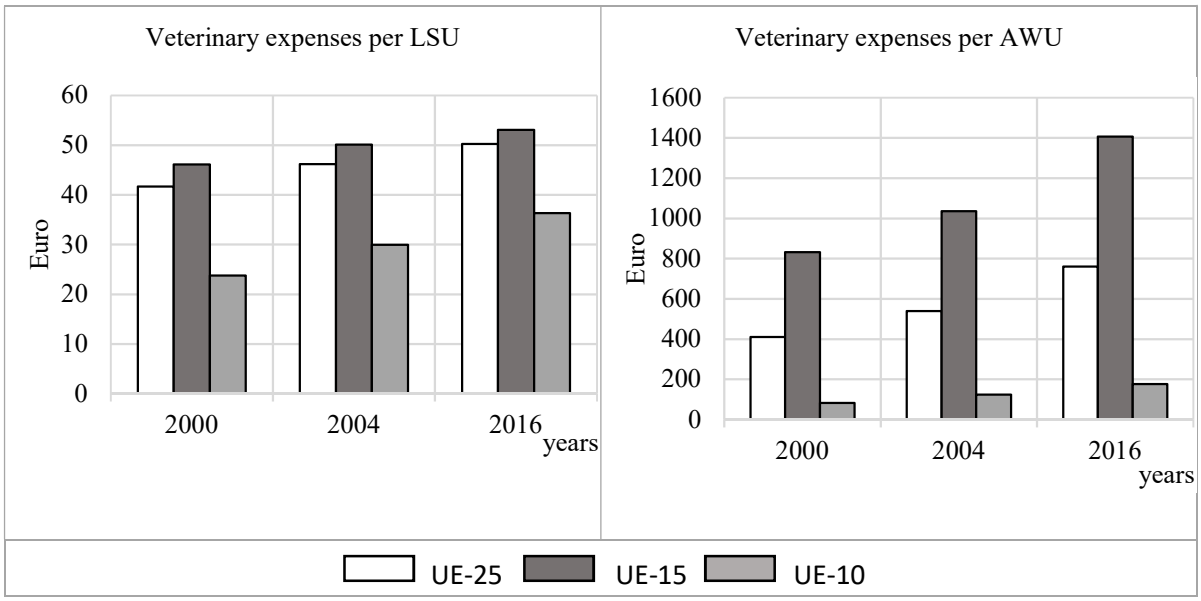
[17] Note that official statistics fail to provide a complete picture of how agricultural services are used, especially in EU-10 countries. They take account neither of free neighbourly help nor of paid services delivered by farmers to the local community (which are not registered and not recorded as non-agricultural activities).

except for agricultural services per hectare of agricultural land in EU-10. In EU-15 countries, the growth of agricultural services value per hectare of agricultural land and per AWU accelerated in 2004, when the new Central and Eastern European countries joined the European Union.

Over the study period, EU-10 countries experienced a decline in average values of agricultural services per hectare of agricultural land. However, this was accompanied by a growth in the value of agricultural services per AWU. With a relatively stable (or slightly declining) amount of land resources, the key reason for the above finding is the rationalisation of employment in the agricultural sectors of these countries. In EU-10 countries, the pace of change remained stable throughout the study period. In 2004, only EU-15 countries recorded a considerable acceleration of growth of veterinary expenses (and only if calculated per AWU). Both EU-15 and EU-10 experienced a consistent increase in veterinary expenses per LSU and per AWU.

Fig. 1. Evolution of the value of agricultural and veterinary services per hectare of agricultural land/per LSU and per AWU in 2000-2016. Average levels for UE-25, UE-15 and UE-10 (EUR, 2016 constant prices)

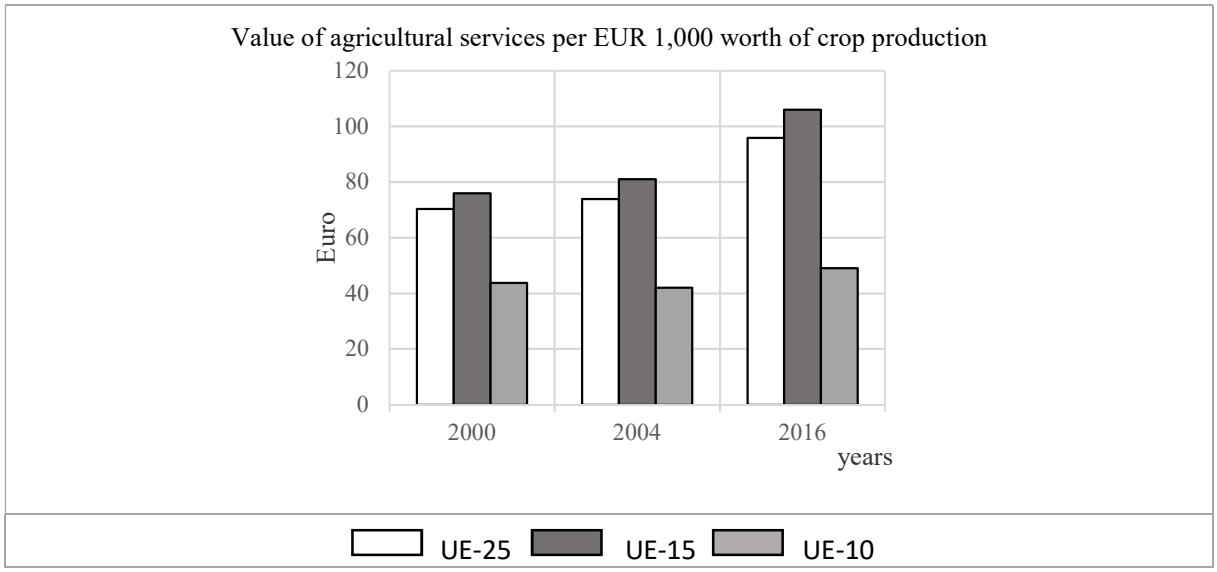


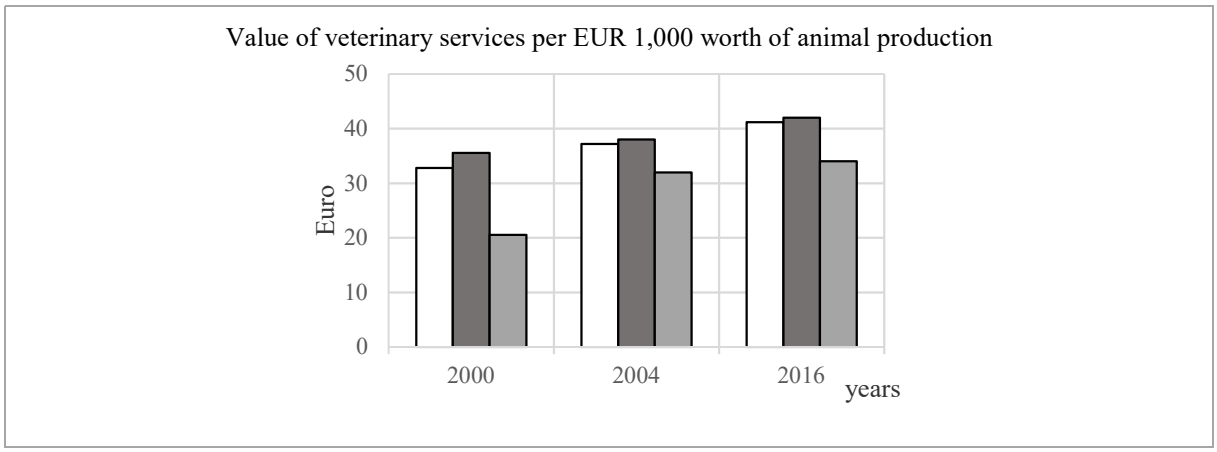


Source: own study based on *Eurostat database* (2013), *Eurostat database* (2016), *Eurostat database* (2017).

Another issue covered by this study was the service intensity rate of agricultural production, expressed as the value of services needed to generate EUR 1,000 worth of agricultural goods output (Figure 2). In the EU-15, that rate grew throughout the study period both for agricultural and veterinary services; the growth accelerated in 2004 (consistently with the value of services per hectare of agricultural land).

Fig. 2. Evolution of the value of agricultural and veterinary services in 2000-2016. Average levels for EU-25, EU-15 and EU-10 (EUR, 2016 constant prices)





Source: own study based on *Eurostat database* (2017).

In the EU-10, the agricultural services intensity rate decreased until 2004. Only after these countries joined the EU did the value of agricultural services per EUR 1,000 worth of agricultural goods output start to grow. However, this was not the case for veterinary services. EU-10 countries needed to align their animal production technology and organisation with the EU's sanitary and quality standards already in the pre-accession period. This is why, in that group, the value of veterinary services grew throughout the study period. Crop production was not under such heavy pressure. Therefore, the farms increased their investments in the upgrading of animal production facilities while crop production was based, to the largest extent possible, on existing resources of machinery (much worn out in most cases[1]) and labour. Note also that in EU-10, labour inputs were and, despite a clear improvement, often continue to be several times higher than in EU-15[2]. Most authors find the increase in the share of services in total production inputs to be a positive aspect which reflects the modernisation of agriculture and economic development [Kołodziejczak 2016, p. 192-193]. The question must, however, also be raised as to whether such an increase is always beneficial. Services are supposed to improve farming efficiency. But in order for this to happen, the increase in their value must be technically and economically justified, and cannot be regarded as an aim in itself. It seems obvious that this is not always the case. There may be various reasons for the increase in value and share of services in total production inputs (e.g. increase in prices, increase in interest rates, additional charges provided for in regulations to be put in place, wear and tear on farm machinery).

However, it may be unreservedly regarded as a positive development only if the value of services grows as a consequence of the farms' reasonable decisions guided by greater

[1] Using the example of Poland, Kukuła (2014, p. 74) states that *in the Polish agriculture sector, the availability of agricultural machinery and equipment* (...) varies from one region to another. This is due to many factors, including historical events. The above is highly likely to be true for other countries under consideration.
[2] See M. Kołodziejczak (2015, p. 464-467), W. Kołodziejczak (2016, p. 133-134).

economic, technological and environmental efficiency of the service compared to the following two alternative scenarios: scenario one consists in using the farm's own labour or contract work, or investing in the purchase and subsequent maintenance of machinery and equipment (which is often too powerful for the farm, and therefore cannot be fully used). Scenario two involves costly repairs of older machinery and equipment (which is often not powerful enough, and requires large amounts of labour to achieve the required output).

The data in Table 1 shows that the use of services varies extremely from one EU country to another, and that the results obtained for specific countries considerably differ from the average values recorded in EU-15 and EU-10 aggregates. Table 1 presents the value of agricultural services (at 2016 constant prices) per hectare of agricultural land, per AWU and per EUR 1,000 worth of crop production in the agriculture of EU countries in 2000 and 2016. In the EU-15 group, the Netherlands and Italy are the two countries reporting the highest value of services per hectare of agricultural land. The highest value of services per AWU was also recorded in the Netherlands, followed by Denmark, France, Sweden, Italy, UK and Germany. Ireland led the ranking for the value of agricultural services per EUR 1,000 worth of crop production, followed by the Netherlands, Denmark, Italy, Sweden, UK and Estonia. The levels of agricultural services per hectare of agricultural land and per AWU recorded in EU-10 countries were several times lower. However, when calculated per EUR 1,000 worth of crop production, the differences are less noticeable. This is because the levels of crop production recorded in the EU-10 are much lower than in the EU-15. Therefore, the use of agricultural services may be found to depend on two basic factors. The first one is the agricultural development level and the intensity and structure of crop production. The second one is the availability of the farms' own machinery and the amount of labour engaged in production. Having one's own machinery does not necessarily translate into a high capital value, especially in EU-10 countries. These can be obsolete machines which, although fully depreciated a long time ago, remain operational; despite their low efficiency, they enable avoiding the purchase of services if enough labour is available to do the field work. On the other hand, these can also be state-of-the-art machines purchased by farmers with funds provided under EU programmes, if they decided to invest in their own equipment rather than rely on services. Therefore, the use of agricultural services is primarily determined by needs which, in turn, are defined by the amount of labour resources, the structure of crop production and the farms' choice between paying for services and investing in their own machinery.

Table 2 presents the value of veterinary services per LSU, per AWU and per EUR 1,000 worth of animal production in the agriculture of EU countries in 2000 and 2016, expressed in

EUR at 2016 constant prices. In the group of EU-15 countries, the highest value of veterinary services per LSU was recorded in Italy, which, however, was outperformed by Bulgaria, a member of the EU-10 group. That index does not vary as much from country to country as does the level of agricultural services per hectare of agricultural land. The lowest values were recorded in Poland and Portugal (in 2000, also in Lithuania and Estonia). However, the values reported by both of these countries in 2016 were several times higher, reaching a level comparable to that of the UK and Hungary, respectively. Despite relatively small differences in the value of veterinary services per LSU, the level of veterinary services per AWU varied strongly from one country to another over the study period. This was caused by differences in labour inputs used in agricultural production across the countries. Note however that the above parameter has little informative value as it does not include data on labour intensity in animal production (instead, the calculation takes account of labour intensity for the entire agricultural production). Therefore, the differences revealed by this analysis mainly result from the amount of labour inputs. As an inevitable consequence of that approach, the value of veterinary services per AWU is low in EU-10 and in EU-15 countries demonstrating relatively high levels of agricultural employment; conversely, it is high or very high in countries with low levels of agricultural employment, such as Belgium, Denmark, France, the Netherlands, Luxembourg, UK, Germany or Ireland. This is why the service intensity rate, expressed as the value of veterinary services per EUR 1,000 worth of animal production, seems to be a more reliable indicator. That ranking is clearly led by Bulgaria, followed by Romania, Czech Republic, France, Belgium, Slovakia, Ireland and Slovenia. In turn, the lowest values were recorded in Portugal, Poland, Sweden and Finland. Note however that the service intensity rate for veterinary services depends not only on production intensity and sophistication but also (at least to the same extent) on the structure of animal output and on veterinary service charges which vary from one country to another.

Table 1. Value of agricultural services per hectare of agricultural land, per AWU and per EUR 1,000 worth of crop production in the agriculture of EU countries in 2000 and 2016 (EUR, at 2016 constant prices)

Countries	Agricultural services per ha of agricultural land		Agricultural services per AWU		Service intensity rate	
	2000	2016[a]	2000	2016[b]	2000	2016
Austria	62.1	102.3	1,255.7	2,588.5	75.8	95.4
Belgium	31.2	35.7	581.5	898.7	10.7	12.9
Bulgaria	111.2	48.3	419.0	753.6	138.3	84.0

Countries	Agricultural services per ha of agricultural land		Agricultural services per AWU		Service intensity rate	
	2000	2016[a]	2000	2016[b]	2000	2016
Czech Republic	8.2	35.5	178.2	1,227.2	17.5	42.0
Denmark	180.8	226.7	6,333.6	11,358.8	96.1	165.0
Estonia	12.4	44.8	152.4	1,988.4	43.5	134.5
Finland	36.0	60.8	719.7	2,589.4	45.7	100.7
France	122.2	158.5	3,310.2	6,866.1	79.8	113.0
Greece	159.8	56.5	977.9	665.3	49.0	40.3
Spain	23.8	20.6	564.1	726.0	20.2	16.7
Netherlands	858.3	1345.9	7,929.6	18,874.6	138.6	184.8
Ireland	74.0	72.9	2,155.9	2,250.7	193.8	204.3
Lithuania	8.9	17.1	118.1	343.3	25.8	30.0
Luxembourg	86.0	24.0	2,550.1	929.0	86.2	18.3
Latvia	8.3	24.3	79.6	558.4	30.5	64.7
Germany	95.1	146.4	2,382.2	5,237.7	60.7	95.3
Poland	30.5	34.4	176.5	265.6	49.3	47.0
Portugal	30.6	42.3	235.1	516.3	26.1	38.8
Romania	31.8	15.3	121.6	138.0	20.0	19.9
Slovakia	36.5	64.1	551.3	2,486.8	130.4	89.4
Slovenia	48.2	36.4	225.6	222.7	34.1	26.6
Sweden	48.6	126.1	1,865.2	6,875.5	51.2	146.9
Hungary	105.5	90.7	710.6	1,055.3	101.3	84.2
UK	102.4	77.7	4,717.2	5,176.9	111.6	134.8
Italy	302.3	404.4	2,855.3	7,027.1	113.1	167.0

[a] amount of agricultural land as at 2013

[b] amount of AWU as at 2013

Source: own study based on *Eurostat database* (2013), *Eurostat database* (2016), Eurostat *database* (2017).

Table 2. Value of veterinary services per LSU, per AWU and per EUR 1,000 worth of animal production in the agriculture of EU countries in 2000 and 2016 (EUR, at 2016 constant prices)

Countries	Veterinary services per LSU		Veterinary services per AWU		Service intensity rate	
	2000	2016[a]	2000	2016[b]	2000	2016
Austria	35.7	51.6	570.4	1,168.6	31.5	39.5
Belgium	57.5	66.2	3,350.5	4,561.4	47.3	55.4
Bulgaria[c]	110.6	119.5	233.6	410.3	69.5	123.7
Czech Republic	29.2	66.1	400.2	1,130.9	38.8	67.9
Denmark	42.9	49.0	2,479.3	3,877.0	24.9	37.9
Estonia	12.4	42.0	62.4	603.7	14.1	37.3
Finland	43.8	35.7	479.4	771.1	19.4	17.7
France	56.9	67.6	1,321.7	2,307.6	47.6	59.3
Greece	44.0	33.7	190.7	175.0	28.6	27.0
Spain	42.5	42.6	579.0	935.6	37.8	37.8
Netherlands	38.4	54.7	1,285.8	2,740.0	25.9	34.9
Ireland	31.5	48.2	1,331.2	1,777.8	36.3	54.0
Lithuania	3.7	23.7	23.0	139.3	6.5	23.7
Luxembourg	57.3	49.5	2,296.8	2,420.1	43.0	39.7
Latvia	41.4	31.2	123.9	185.4	41.4	33.2
Germany	40.1	49.4	1,132.6	1,946.0	31.5	38.0
Poland	7.8	10.9	34.7	53.7	10.0	8.9
Portugal	8.3	13.0	42.2	88.4	7.2	10.0
Romania	47.1	56.5	93.6	193.7	25.7	74.4
Slovakia	36.7	66.5	253.6	874.4	35.9	54.5
Slovenia	54.4	57.2	320.6	351.2	44.6	52.8
Sweden	19.1	20.0	471.5	616.1	11.6	12.8
Hungary	31.9	26.3	146.0	148.3	23.9	22.0
UK	41.0	42.0	1,891.7	2,172.9	32.3	36.8
Italy	75.4	79.0	543.4	1,064.2	44.1	49.5

[a] amount of LSU as at 2013, [b] amount of AWU as at 2013, [c] as at 2000, data on veterinary services as at 2002.

Source: own study based on *Eurostat database* (2013), *Eurostat database* (2016), Eurostat *database* (2017).

Table 3 shows the correlation between the use of production services in agriculture and the variables referring to agricultural development in groups of European Union countries in 2000-2016. Even a cursory analysis of the results indicates the difficulty of finding any universal relationships. The correlations presented separately in Table 3 for EU-25, EU-15 and EU-10 suggest above all the prevailing role of the situation in the EU-15, which affects the direction of relationships in the EU-25, the aggregate of all countries. In EU-15 countries, there is evident correlation between the use of services and fixed capital formation. A similar direction of relationships is observed in EU-10 countries. However, in that group, the positive correlation is weaker for agricultural services but tends to be stronger for veterinary services. This could result from the impact of aid schemes which help farmers invest in new, more powerful machinery and equipment. While the availability of their own machinery makes farmers less likely to use agricultural services, it does not affect the use of veterinary services, because of the veterinarians' required knowledge and competencies.

Table 3. Correlation between the use of production services in agriculture and the variables referring to agricultural development in groups of European Union countries in 2000-2016[a]

		ASO	VE	TIC	AGO	CO	ANO	GV	EI	GFCFP	GFCFA	GFCFM	GFCFE	GFCFT	GFCFB
EU-25	ASO		+++	+++	+++	+++	+++	+++	++	++	++	+++	+++	+	+++
	VE	+++		+++	+++	+++	+++	+++	++	++	++	+++	+++	++	+++
EU-15	ASO		++	+++	+++	+++	+++	+++	++	++	++	+++	+++	+	+++
	VE	++		+++	+++	+++	+++	+++	++	+	+	+++	+++	+	++
EU-10	ASO		+	++	++	++	++	++	+	+	+	+	-	+	+
	VE	+		+++	+++	+++	+++	+++	++	+++	++	+++	++	+++	++

[a] Panel correlation analysis of time series spanning from 2000 to 2016, $p<0.05$. The values of variables compared are expressed in constant prices per hectare of agricultural land. The values of correlation coefficients are marked as follows: "+" below 0.3 (weak correlation); "++" 0.3-0.7 (moderate correlation); "+++" 0.7-1.0 (strong correlation). Negative correlation is marked as follows in the corresponding intervals: "-", "-- " and "---".

Abbreviations used in table headers have the following meanings: (ASO) agricultural services output, (VE) veterinary expenses, (TIC) total intermediate consumption, (AGO) agricultural goods output, (CO) crop output, (ANO) animal output, (GV) gross value added, (EI) entrepreneurial income, (GFCFP) gross fixed capital formation in plantations, (GFCFA) gross fixed capital formation in animals, (GFCFM) gross fixed capital formation in materials, (GFCFE) gross fixed capital formation in machines and other equipment, (GFCFT) gross fixed capital formation in transport equipment, (GFCFB) gross fixed capital formation in buildings.

Source: own study based on *Eurostat database* (2017).

Thus, by contributing to the scaling up, or modernisation of production processes, fixed capital formation will rather increase the willingness to use veterinary services. It can be

therefore assumed that the development of the farms' own potential may be accompanied by an increase in service expenditure in the case of crop production in highly developed countries with high inputs per hectare of agricultural land; or may substitute service expenditure in the agricultural sectors of converging economies which supplement or upgrade their own resources of fixed assets (crop production machinery, equipment and infrastructure). Because of the specific nature of animal production and veterinary services, the positive correlation between fixed capital formation and veterinary expenses is stronger in the agriculture of less developed countries (which supplement or upgrade their own resources of fixed assets) than in than the agriculture of highly developed countries.

Summary

1. Production services support the rationalisation of production processes. Tapping into the service providers' potential and knowledge is a way to reduce the costs of building and maintaining farms' own potential, to improve production performance and to enhance product quality. Services also drive progress and promote access to knowledge on manufacturing organisation and technologies.
2. The differences in the use of production services observed across the EU allow the conclusion that EU-15 countries report higher average levels than EU-10 countries. This suggests a relationship between economic (including agricultural) development levels and the use of production services. However, the analysis of particular countries shows that the specific nature of local agriculture is at least equally important. The use of agricultural services may be found to depend on two basic factors. The first one is the agricultural development level and the intensity and structure of crop production. The second one is the availability of the farms' own machinery and the amount of labour engaged in production. As regards livestock production, the key determinant is the amount of labour inputs.
3. In EU-15 countries, there is evident correlation between the use of services and fixed capital formation. A similar direction of relationships is observed in EU-10 countries. However, in that group, the positive correlation is weaker for agricultural services but tends to be stronger for veterinary services. It can be assumed that the development of the farms' own potential may be accompanied by an increase in service expenditure in the case of crop production in highly developed countries with high inputs per hectare of agricultural land; or may substitute service expenditure in the agricultural sectors of converging economies which supplement or upgrade their own resources of fixed assets (crop production machinery, equipment and infrastructure). Because of the specific nature of animal production and veterinary services, the positive correlation between fixed capital formation

and veterinary expenses is stronger in the agriculture of less developed countries (which supplement or upgrade their own resources of fixed assets) than in than the agriculture of highly developed countries.

4. The use of production services may support the evolution towards sustainable agriculture as regards the following aspects: reduced environmental impact; improved food safety; preserving the environment and the cultural and environmental characteristics of rural areas. However, in order for this to happen, the principles of sustainable development need to be taken into account, in addition to immediate economic benefits, in the decisions made by farm managers. The use of services itself is not decisive for the degree of agricultural sustainability, because services are only a tool which may be used or misused.

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