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## Agricultural knowledge and rural economy – analysis on micro and macro scales

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**Abstract:** *In this paper agricultural knowledge and economic activity of farms are analysed from different perspectives. The research on the role of knowledge in stimulating agricultural and rural development was conducted with the main focus on the EU agricultural rural policies. The authors provide a scientific procedure that delimitates rural areas of Poland according to their potential to expand agricultural activity versus multifunctionality of rural areas.*

**Keywords:** *knowledge transfer; rural policy; multidimensional analysis; education*

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### Knowledge in agricultural and rural development from the perspective of the New Member States

Despite its diminishing role in the economy, agriculture retains its position as primary sector. That reflects the superiority of demand for food over the other human economic activity products. The superiority of food production resulted in extraordinary efforts to maintain agricultural activity even if it is not economically justified. Therefore agricultural activity can be observed even on areas that are not suitable for food production. European agriculture is a particular example of such a phenomenon with heavy spending of public money on agricultural subsidies. On the other hand, agriculture is recognised as a part of the rural environment with conservation of the countryside and social functions. These have a public goods nature and are seldom directly valued by market (Ruttan, 1994). Achievement of food security in developed countries accompanied with globalisation resulted in a changing paradigm of rural and agricultural development toward improvement of competitiveness

(Coleman et al., 2004). However, in the case of Europe the multifunctional concept of development has prevailed stressing different functions of agriculture and still unexploited possibilities of diversification of the rural economy (Van Huylenbroeck and Durand, 2003). Multifunctional rural development does not contradict the privileged position of agriculture in rural areas pointing out its role in providing public goods and the importance of other sectors of the rural economy. However it is necessary to improve productivity of agriculture to become competitive on the global food market. This concept is based on knowledge of agronomy and ability of a farmer to recognise and adopt most the promising technologies as well as to gain the knowledge necessary for running a non-agricultural business.

Coexistence of the above mentioned two directions of development causes certain problems related to utilisation of rural areas. For example improvement in competitiveness of agricultural production is based on economy of scale and know-how transfer. In practice farms tend to increase their size and implement new technologies. On the contrary, the multifunctional concept of rural development requires the conservation of agricultural land and an increase of its utilisation for non-agricultural activities. As a result, the competition for land is growing.

There are some possibilities to overcome problems resulting from the many-sided directions of rural development which are connected with knowledge transfer and implementation of innovations (Floriańczyk et al., 2009). From one side the competitive farms desire highly specialised technologies while according to the multifunctional rural development concept the needs are more related to knowledge of non-agricultural possibilities. Both ways of development are strongly interrelated while knowledge transfer demanded.

The role of knowledge transfer in rural and agricultural development is widely recognised and stressed in regional development policies. In the case of European Union (EU) training programmes for farmers as well as the programmes aiming for the implementation of modern agricultural technologies are included in the Common Agricultural Policy (CAP). However, the general trend of a decreasing number of full time farmers indicates that only some of the beneficiaries of these programmes take full advantage of their knowledge in agriculture. That indicates the growing competition for agricultural knowledge capital between different sectors of the economy. The growing possibilities of employment in non-agricultural sectors can lead to withdrawal of human capital from farms which are not able to provide satisfactory incomes. In such a case the increase of agricultural type of knowledge instead of providing a base for development of farms has an opposite effect. This phenomenon can be described as a two-layer inefficiency. The first results from unnecessary public spending on such a knowledge increase that is only partly taken advantage of. The second level of inefficiency is related with failure to provide rural areas with non-agricultural knowledge that is more appropriated to multifunctional development.

The problem of adequate knowledge transfer in Europe is likely to be more often observed in regions with large numbers of subsistence farms. They are characterised by traditional transfer of knowledge that favours informal rather than formal type of knowledge. The first one is based on succession and own experience. In the light of knowledge base economy informal type of knowledge in most cases rejects recent research and development achievements and is of secondary importance in rural development. Taking advantage of the latest technologies requires intensification of formal knowledge transfer (Klepcki, 2005).

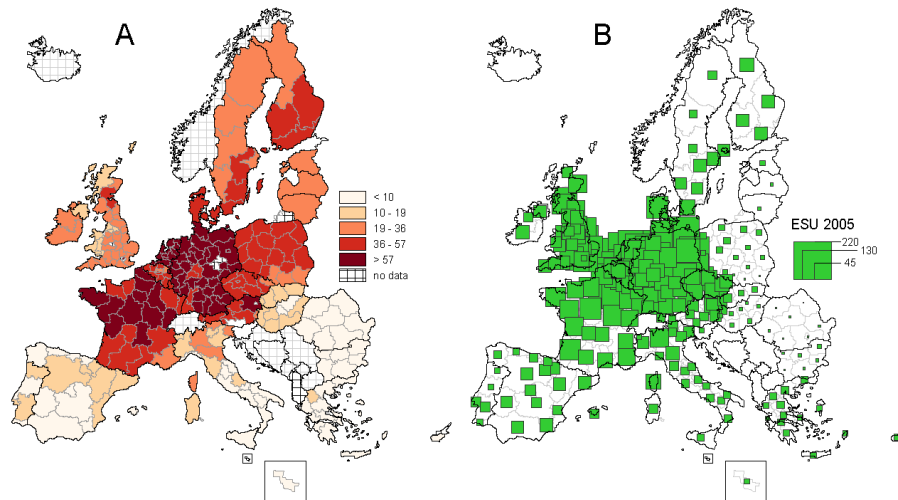
The accession of Poland to the EU created new challenges and opportunities for agriculture and rural development (Zegar and Floriańczyk, 2003). Challenges are mostly related to the transformation of peasant type of farming into family farms that are able to compete in the EU market. Taking into account the multifunctional concept of development the most promising path of development of these farms is linked with exploration of non-agricultural rural opportunities. This transformation can be supported in different ways through rural development programmes co-financed by the EU budget including instruments aiming for knowledge transfer.

In this paper the relationship between agricultural knowledge level and farm performance from the Polish perspective is investigated. Regions of high potential of withdrawal of human knowledge from the agriculture sector are identified. On this basis a model of farms that are likely to effectively take advantage of knowledge will be proposed. Finally results of the research will support the process of programming rural policies directed at human capital improvement in rural areas. Different research approaches are examined to give scientific added value, thanks to its complementary. Starting from an EU perspective, through detailed analysis at the farm level, into the spatial approach, complex and multidisciplinary investigation is provided. A very detailed level of spatial analysis (over 2000 units) should give much information about human resources (human capital) in rural areas in respect to its functional features.

### **Agricultural knowledge level from EU perspective**

The EU from the spatial perspective can be characterised as highly diverse in almost all spheres of socio-economic development. Similar disparities among EU regions concerning level of education of farm operators and farm size are easy to recognise (Figure 1). The highest share of farmers with agricultural education can be observed in northern part of France, in Germany and the Benelux countries. Near those countries are located regions characterised by the average values of the analysed indicator, including regions of Poland. On the other side, the regions of southern Spain, Italy and Greece together with the whole territory of Bulgaria and Romania have low shares of farmers with agricultural education.

Similarly the highest averages of economic size are observed for farms in German and Dutch regions – among 14 regions with the average value higher than 100 ESU, nine German regions and Dutch regions were presented (Economic Size Unit is used for expressing the economic size of farms by Farm Accountancy Data Network [www.fadn.pl](http://www.fadn.pl)). The lowest values of average economic size of farms were observed in New Member States i.e. Romania, Bulgaria and southern part of Poland with small number of farms of economic size higher than 100 ESU.



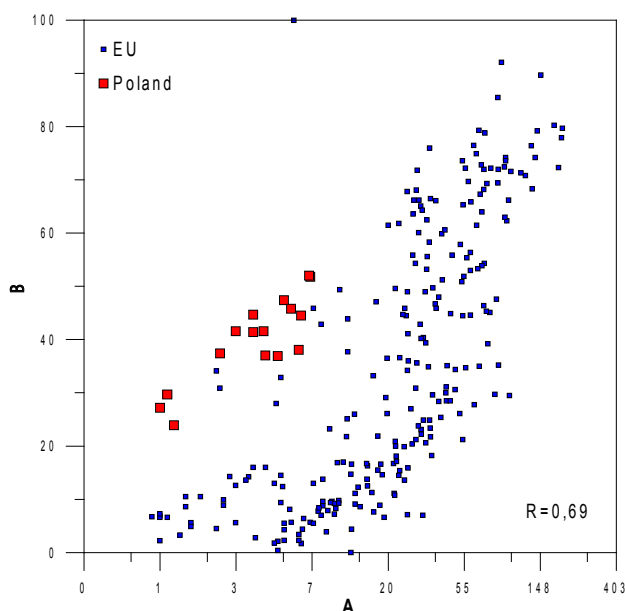
**Figure 1. Share of farms operators with agricultural education (A) and average economic size of farms in ESU (B) in European Union regions in 2005**

Source: elaborated on the basis of DG AGRI data

The FADN data for EU regions (NUTS3 level) are characterised by strong correlation ( $r=0.69$ ) between the level of education of farmers and the economic size of farms (Figure 2). Polish regions as compared with EU ones can be characterised by the average level of farmer education and lower economic size of farms. This suggests that knowledge capital in Polish agriculture is less effective than expected in terms of transferring it into farm development. Indeed, quantified model of transformation knowledge at EU level proves the unsatisfactory effectiveness of Polish farmers. According to the regression model Polish farmers could operate farms that are almost ten times larger than observed (39 ESU instead of 4 ESU). Assuming that the relationship between analysed data is non linear, Polish farms are characterised as being five times smaller than expected considering average economic size (average of expected value from the model 22 ESU). The most important factor that affects such results is incompatible agrarian structure in Polish agriculture – the average farm area is only 8 ha.

The study shows a high potential for multifunctional development of Polish (and New Member States) rural regions. Higher level of education accompanied with low economic potential of farms suggest that the economic situati-

on of rural areas of Poland could be significantly improved while more rural knowledge resources are utilised outside of agriculture.

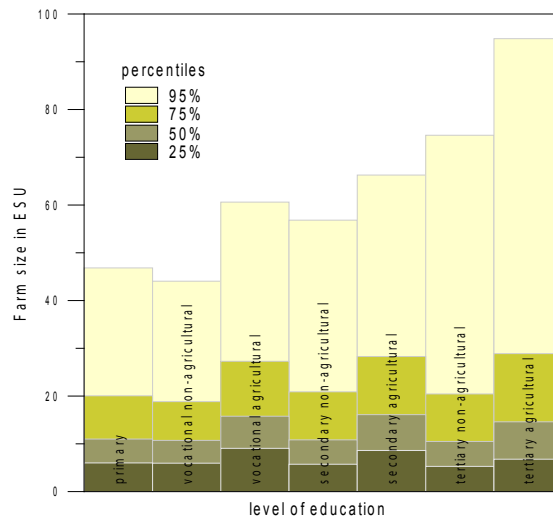


**Figure 2. Interdependencies between the average economic size of farm in ESU (logarithmic scale) (A) and the average level of agricultural education of farm operators (B) for 2005**

Source: elaborated on the basis of DG AGRI data

### Microeconomic analysis of interdependencies between knowledge and agricultural performance

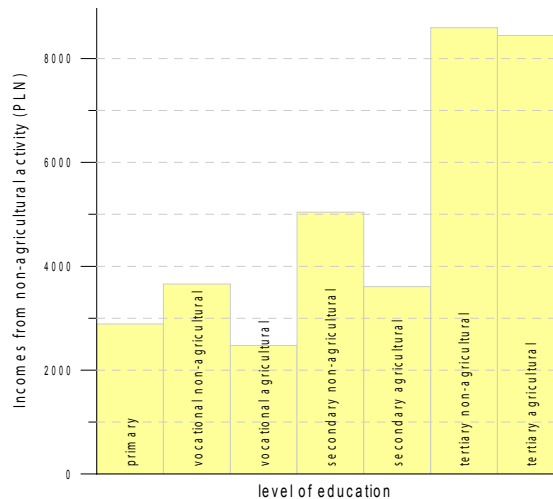
The analysis of microeconomic interdependencies between the level of farmers' knowledge and economic performance of the farms is based on Farm Accountancy Data Network data. In the case of Poland the FADN sample includes about 12 thousand farms, which represent 750 thousand farms, that is nearly all farms that participate in the agricultural market (More information about Polish FADN is available at <http://www.fadn.pl/index.php?id=156>). Microeconomic data analysis proves interdependency between the level of education of the farm operator and the economic size of the farm. The group of farms run by farmers with tertiary agricultural education includes more than 25% farms of economic size higher than 20 ESU (Figure 3). On the other hand more than 75% farms operated by farmers with primary education do not exceed 20 ESU. These differences are of greater importance while taking into account that farms run by an operator educated at primary level never exceeded the level of 50 ESU, which was observed in more than 10% of farms whose holders were educated at tertiary level.



**Figure 3. Interdependencies between level of education of farm operators and value of production per 1 AWU**

Source: elaborated on the basis of FADN data for 2006

A similar analysis of dependency between level of education of farm operator and level of incomes from non-agricultural activities shows the better position of farmers with higher level of education. Farmers in this group are characterised by more than twice as high non-agricultural incomes as in the other groups. This suggests that farmers with tertiary education can be also regarded as leaders of multifunctional rural development (Figure 4).



**Figure 4. Interdependencies between level of education of farm operators and incomes from non-agricultural activities (PLN per farm)**

Source: elaborated on the basis of FADN data for 2006

These microeconomic studies indicate that only some, mostly those run by farmers with a high level of knowledge, farms in Poland fit the EU level knowledge/economic size of farm model. However this group is also rather heavily engaged in non-agricultural activities. On the other side, the relatively higher level of education of Polish farmers stresses problems with non-agricultural knowledge transfer. This directly effects their ability to utilise scarce farm resources in other activities.

### **Spatial analysis of farmers' level of knowledge and economic performance of farms**

Delimitation of rural areas of Poland according to two basic elements: knowledge and productivity (e.g. high knowledge with high productivity) was conducted. Thanks to this, it was possible to point out areas with a future perspective of agriculture function and areas where because of high "brain drain" agriculture development is highly questionable.

Human resources, particularly their quality, play the key role in regional development. Depending on the quantity and quality of these resources, they can constitute either an essential barrier or a stimulator of development (see, e.g. de la Fuente and Ciccone, 2003; Lee et al., 2004; Tondl and Vuksic, 2003). An important aspect of the contemporary socio-economic processes is constituted by their close association with concrete location and the features shaped by it – the local, unrepeatable resources. A strictly localized in space, partly immobile, social system influences the development capacities of an area. In other words, according to theory of new economic geography – "location matters" (Fujita et al., 1999).

Particularly nowadays, the existing coefficient between efficiency of agriculture production and the level of education plays a more and more important role. The adjusting to greater requirements in relation to quality of agricultural production, carrying out the modernization of agriculture as well as absorbing a bigger amount of external funds, can be particularly difficult in areas characterized by a high share of farmers with low levels of education and skills (Bański, 2007).

**Table 1. Structure (%) of people working in Polish towns and in rural areas (in agriculture and beyond), 2006**

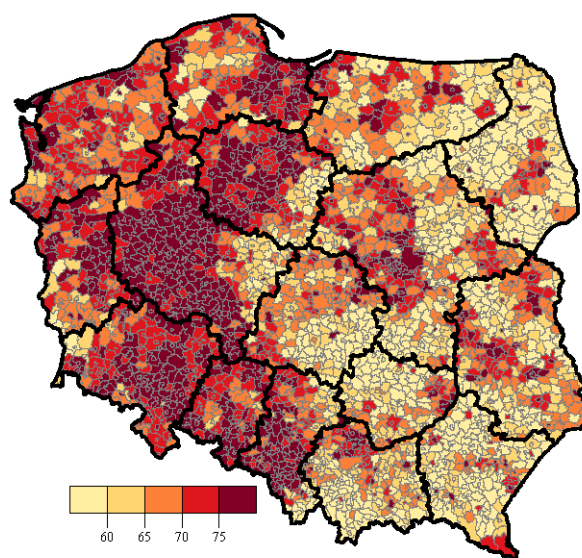
Level of education	Towns	Rural areas	
		Individual agriculture	Outside agriculture
Tertiary	29.7	2.2	14.7
Secondary	42.4	22.5	35.6
Vocational	23.5	43.8	39.9
Primary	4.4	31.5	9.8

Source: Own calculations based on data from Central Statistical Office



A clear difference in the educational level of people working in rural areas in agriculture and in non-agricultural activities can be shown (Table 1). In 2006 over half the people working in non-agricultural sectors of the economy had secondary or tertiary education while in agriculture only ¼ of farmers. The differentiation results both from the later rise and development of system of agrarian education in relation to different professional groups as well as the traditional perception of agricultural sector.

The level of education of farmers reached the highest values in the central part of the Wielkopolska Region and south-western Kujawsko-Pomorskie Region, as well as in the majority of cities and their suburban zones (e.g. Wrocław, Gdańsk). Moreover, high values were noted in the whole Silesia region, the remaining areas of Wielkopolska and the Kujawy, the Vistula Delta and Pomerania as well as in the suburban zone of Warsaw (Figure 5). The least desirable situation was observed in rural areas of eight regions in the eastern part of country (except for suburban zones and some areas with intensive agricultural production).

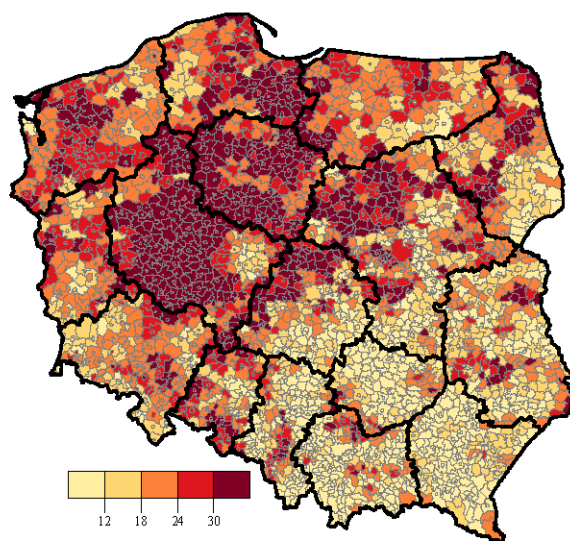


**Figure 5. Share of farmers with higher than basic general educational level in 2002**

Source: Own calculations based on data from Central Statistical Office

In case of agricultural education, from among almost 1.6 million farmers, only 1.3% have tertiary agricultural education and more than 19% possessed secondary or vocational agricultural education. Almost 800 thousand farmers did not possess any professional education. Again Wielkopolska, Kujawy regions and the Vistula Delta were characterized by good structure of the farmers' agricultural education. Such spatial differentiation is closely related with qualitative features of agriculture. The areas with domination of intensive agriculture have also higher shares of farmers with agricultural education. For

areas of south-eastern Poland non-market oriented agricultural production (semi-subsistence) and unfavourable structure of the farmers' education are characteristic (Figure 6).

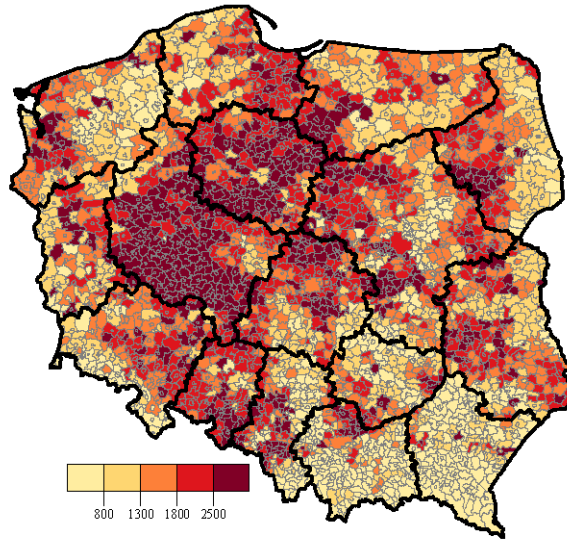


**Figure 6. Share of farmers with higher than basic agricultural education in 2002**

Source: Own calculations based on data from Central Statistical Office

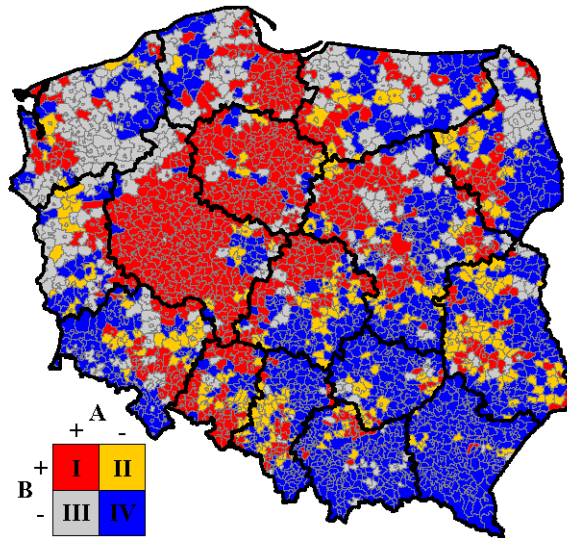
In case of spatial analysis, the economic performance of agricultural farms was described by the level of productivity of private agriculture. It is defined as the value of production sold on the market expressed in Polish zloty (PLN) per one hectare of farm (Kulikowski, 2003). The highest values of that measure were observed in Wielkopolska Region (pig breeding, intensive plant cultivation), Kujawy Region (industrial crops), south-western of Warsaw suburban zone (orchards), western Podlasie (cattle breeding) and among Vistula Valley (vegetables) (Figure 7).

After describing the spatial diversification of educational level and level of farm productivity, it is important to show the global dependency between agricultural knowledge and the rural economy. For this purpose the spatial typology of areas according to these two elements was created. Thanks to that, it was possible to delimitate areas with high perspective for developing agriculture function – there are mostly communes delimitated to I class (31% of total communes). There were mainly Wielkopolska Region, Kujawsko-Pomorskie Region, Vistula Delta, northern part of Łódzkie Region and north-western of Mazovia Region (Figure 8).



**Figure 7. Value of commercial agricultural production in PLN per 1 ha, 2002**

Source: Own calculations based on data from Central Statistical Office



**Figure 8. Spatial typology of communes according to level of agricultural productivity (A) and agricultural education of farmers (B)**

Source: Own work

These rural areas have the perspective to base their development on market oriented agriculture. By contrast, there are 42% of communes (IV class) which have to find other ways for development because both investigated characteristics (endogenous potential expressed by educational level and productivity

of agriculture) were above average values. What is interesting is that there are a few communes delimited to transitory classes (II and III class – 17%). Having in mind the importance of such factors as agrarian structure, type of land use, environmental conditions for agricultural production and physical size of farms for farm's economic condition, it has to be emphasised that nowadays knowledge is a key factor in spatial differentiation of agricultural productivity and farmers' income.

## Discussion

Application of three different research approaches allowed the delimitation of Polish regions according to their farmers knowledge – economic potential characteristics. The EU dimension model demonstrated lower than expected efficiency of Polish farmers in transferring their knowledge in farm development. The relatively higher level of education of farmers was accompanied by several times lower farm sizes than predicted by the model for EU agriculture. That is a result of the relatively slow transformation of farm structures as compared with most EU countries. This phenomenon leads to the conclusion that human resources in Polish agricultural sector are not properly utilised. Therefore the hypothesis of high possibilities of improvement of rural economy through multifunctional development could be in force. However, the micro-economic analysis showed that only a limited number of farms in Poland are operated by highly educated farmers. What is important is that these farmers are also the most active in non-agricultural rural businesses. Combining the outcomes of research conducted on EU and Polish dimensions pointed out that currently only a some of the biggest farms in Poland have an adequate human resources level to stimulate multifunctional development of rural areas. Therefore, first of all, there is a high demand for non-agricultural knowledge in rural areas. This can increase the human capital available in small farms that are unable to compete in the food market and should connect their future with non-agricultural sectors of the economy.

Spatial analysis helps to distinguish at the commune level regions that are of high potential for further expansion of agriculture production and multifunctional development. Namely Wielkopolska Region, Kujawsko-Pomorskie Region, Vistula Delta, northern part of Łódzkie Region and north-western of Mazovia Region could be recognised as agricultural. On the other hand, the development of the rural areas of south-eastern part of Poland should be associated with implementation of multifunctional concept but requires intensification of non-agricultural knowledge transfers.

These research outcomes should be directly used for programming policies aiming at improvement of human capital and rural economy. It allows for precise formulation of policy instruments in order to increase their efficiency and finally ensure sustainability of rural development. It should be emphasised that knowledge in any dimension (spatial and microeconomic) is crucial in the development of the rural economy. But, knowledge that is practically utilised

is a characteristic of “a few” farmers. We suppose that the efficiency of rural areas of Poland (also other parts of Europe) could be significantly improved by creating a professional system of formal education. Such a system will transform a number of well-educated farmers from “a few” to “a lot”.

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