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ANALYSIS OF COSTS RELATED TO BUILDINGS, MACHINERY AND EQUIPMENT BASED ON FADN DATA

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Abstract. *Successful agricultural production requires appropriate fixed assets, while investments in their improvement and modernization are necessary for long term sustainability of agricultural holdings. As a consequence, costs related to fixed assets have significant share in total costs (total input) of farm activity. This research primarily analyzes costs related to buildings, machinery and equipment. As a base for the research FADN methodology is applied as well as EU FADN public database as a source of data. Within the analysis authors primarily discussed elements of Total faming overhead (SE336), such as Machinery and building current costs (SE340), Energy (SE345) and Contract work (SE350). Above mentioned FADN indicators cover variety of costs, such as costs of current upkeep of machinery and buildings, costs of fuel and electricity and costs linked to the hire of machinery, among others. Costs are discussed and compared for 14 farm types in the EU (TF14 classification of farms is applied). The results of the analysis enabled better insight and understanding of costs related to machinery, equipment and buildings in agricultural production of the EU, while the conclusions could be useful for Serbian agricultural holdings, as well.*

Key words: fixed assets, overhead costs, FADN, costs of current upkeep, energy costs

INTRODUCTION

Analysis of business performance of EU farms is commonly based on FADN (Farm Accountancy Data Network) methodology, and appropriate database (as reliable source of data). FADN system offers information on farm revenues and costs (Njegovan and Nastić, 2011) while enabling determination of "the impacts of Common Agricultural Policy for Member States of the EU" (Dabkienė, 2016). It is necessary to keep in mind that FADN collects only limited volume of data, so that certain analysis (such as determination of gross margin for individual enterprises) require additional data or specific methodological approaches (Ivanović et al., 2018). Total costs (total input) in FADN methodology are made of following four elements (European Commission, 2022): Total specific costs, Total farming overheads, Depreciation and Total external factors. Apart from depreciation costs (which are not subject of this analysis) other costs related to buildings, machinery and equipment are presented within Farming overheads (SE336). Farming overheads include:

- Machinery and building current costs (SE340),
- Energy (SE345),
- Contract work (SE350) and
- Other direct inputs (SE356).

Machinery and building current costs are "Costs of current upkeep of equipment (and purchase of minor equipment), car expenses, current upkeep of buildings and land improvements, insurance of buildings" (European Commission, 2022). On the other hand "major repairs are considered as investments", so that they are not an element of farming overheads. Energy assumes "motor fuels and lubricants, electricity, heating fuels". When it comes to contract work it covers "costs linked to work carried out by contractors and to the hire of machinery". Other direct inputs are the only element of farming overheads which is not necessarily strongly connected to the use of machinery and buildings (containing costs of water, insurance etc).

FADN data are increasingly used to determine cost structure of EU farms. Hloušková et al. (2018) analyzed Czech FADN data for years 2001 and 2014 determining that share of energy costs in total costs significantly increased in observed period (from 1.8% to 11.1%) while opposite trend could be noticed when it comes to maintenance costs (their share have decreased from 7.6% in 2001 to 5.9% in 2014). After testing various approaches to cost forecasting authors concluded that "not only one of the tested methodologies can be selected to predict various cost types". Dachin (2016) observed farms of different economic size producing field crops in Romania, while data for the research were provided by FADN. In year 2013 farming overheads were dominated by energy costs which are followed by costs of contract works (the same pattern is observed for all farm sizes). Koloszko-Chomentowska and Vilkeviciutė (2020) also used FADN data to analyze performance of farms in Poland and Lithuania (two farm types were observed - farms specialized in field crops and farms specialized in milk production). Authors determined that (when it comes to field crops) total farming overheads participate in total costs somewhere between 25.54% and 26.29% in Poland and between 19.60% and 21.63% in Lithuania (considering period 2015 - 2017). Similar share of total farming overheads in total costs is recorded for milk production farms in both countries. Besides, it can be concluded that overhead costs of both production types are dominated by energy costs which are followed by machinery and building current costs.

Strzelecka and Zawadzka (2019) used FAND data from Poland to determine cost structure for farms of various production types. Authors show that the highest share in total costs (regardless of the production type) could be attributed to intermediate consumption (comprising of direct costs and farm overhead costs). Similar, but more elaborate research conducted by Galecka (2021) compared data covering farms in Poland and the EU (the analysis was performed on FADN dataset for various farm types). During observed period in the EU (from 2013 to 2018) participation of total farming overhead in total costs decreased (except for other grazing livestock and granivores). The highest share of total farming overhead (EU farms) in year 2018 was recorded for field crops (29.85%), while overhead costs were the least important in granivores production (15.31%).

Parzonko et al. (2019) discussed energy costs related to dairy farms operation in seven EU countries, while the research was based on FADN data. The results indicated that share of energy costs in total costs varied depending not only on country but also on farm size. It was concluded that "an increase in the economic size of farms focused on milk production, resulted in energy cost savings in relation to 100 kg of milk produced". Mixed crop and livestock production type of farming was in a focus of research conducted by Špička (2014). Author intended to determine production efficiency of such farms in different EU regions (in total 101 EU regions were discussed for year 2011), as well as factors influencing production efficiency (based on FADN data). Some of analyzed factors were energy costs, machinery & building current costs, as well as contract work. The regions which are more efficient have higher "energy productivity, capital productivity and productivity of contract work" comparing to less efficient regions.

Biekša (2016) used FADN data to evaluate cereal farms using ecological footprint approach. The results of the analysis show that use of agricultural machinery have significant impact on the environment. Therefore, according to author "reduction of energy use and increase of energy efficiency should be the main goal for farming activities". At the same time Wysokiński et al. (2020) explained importance of energy use for GHG emissions, and suggested the ways for limitation of such a negative impact on environment, such as "the development of energy based on renewable sources" and "the improvement of energy efficiency". Authors also claimed that "economic and energy efficiency can be understood as a concept referring to the efficiency of energy use as a resource". Rokicki et al. (2021) observed features of energy consumption related to agricultural production activities (for 28 EU counties in period 2005-2018 on the basis of EUROSTAT data set). The data have revealed that oil and petroleum products are the most important energy source used in agriculture, while agricultural production "produced more renewable energy than it consumed". Authors also found out that increased use of energy is linked to better economic situation. On the other hand, use of renewable energy is related (but not strongly) to economic situation, due to its dependence on environment protection issues. Because of increasing use of mechanization, agricultural production in future will use more energy, while "increase in mechanization will be faster than the development of energy-consuming technologies". According to the authors, this is the reason why renewable energy will become even more important. Ivanović et al. (2012) have determined that an increase in fuel prices leads to a decrease in family farm profit by 35.56%, which makes this input distinguished for its importance for profitable operations of the observed farms. Todorović et al. (2018) used model of family crop farm to determine how the change of diesel fuel market price (authors started from the assumption that market price of fuel fluctuates in interval ±10%) influences the change of efficiency ratio of the total farm production. Calculations were made for production with subsidies and without them, as well as for two initial presumptions – when the sowing structure of farm was not optimized and when it was. The results of the analysis indicated that (if optimal sowing structure was used) production is economically efficient even without subsidies, except for the case with maximized fuel price.

Having above mentioned in mind, this research tends to analyze costs related to buildings, machinery and equipment for 14 farm types present in the EU (TF14 classification of farms), while the focus is on the costs included in farming overheads (SE336).

MATERIAL AND METHOD

The analysis is based on FADN methodology covering EU countries for period 2004 – 2021, while the source of the data was FADN public database. The data are related to classification of farms in 14 types describing specialized and mixed farms types, such as: Specialist COP (Specialist cereals, oilseeds and protein crops), Specialist other fieldcrops, Specialist horticulture, Specialist wine, Specialist orchards – fruits, Specialist olives, Permanent crops combined, Specialist milk, Specialist sheep and goats, Specialist cattle, Specialist granivores, Mixed crops, Mixed livestock and Mixed crops and livestock.

Total assets and fixed assets are discussed (depending on farm types) as well as value of specific fixed assets (Buildings, Machinery and equipment), and costs related to their use. To perform the analysis authors also used data on total input and total output of observed farm types, and determine energy efficiency of the farms as relation between their total output and energy costs. Trends of important indicators are determined, while cumulative growths of asset value and certain costs are discussed.

RESULTS AND DISCUSSION

The analysis revealed that there has been an increase in value of total assets (SE436) and fixed assets (SE441) of average EU farm during period 2004 – 2021. At the same time negative trends are observed concerning participation of fixed in total assets (Fig. 1).

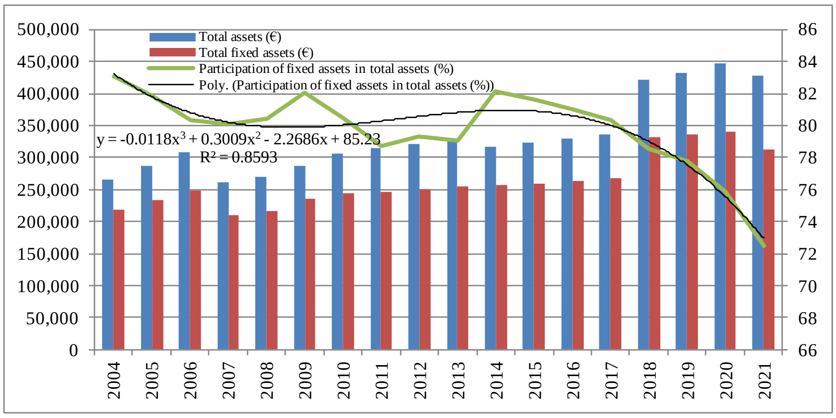

Fig. 1 Value of total and fixed assets (EUR) and participation of fixed in total assets (%)
Source: FADN public database and authors calculation

During observed period total assets increased by 61.4%, while fixed assets increased only by 42.2% (in average) (Table 1). The highest increase of total assets and fixed assets was recorded for mixed livestock. On the other hand, specialized sheep and goats farms were the only farm type with decreased value of both types of assets (total and fixed). When it comes to changes in value of buildings as well as machinery and equipment – mixed livestock type of farming performed the best (has the higher percent of increase). Specialist sheep and goats farms were the only one with deceasing value of machinery and equipment. It could be noticed that during the observed period value of buildings (in average) has the lowest cumulative growth (32.4%). It was caused by decrease of value of buildings for 6 types of farming.

Table 1 Cumulative growth of assets for various farm types (%)

14 Types of Farming	Cumulative growth (2004-2021) (%)			
	Total assets	Total fixed assets	Buildings	Machinery and equipment
(15) Specialist COP	13.0	4.7	-10.4	21.9
(16) Specialist other fieldcrops	37.4	27.2	-1.8	12.8
(20) Specialist horticulture	65.4	34.3	8.8	25.7
(35) Specialist wine	36.2	9.0	15.8	8.2
(36) Specialist orchards - fruits	48.9	30.1	14.0	53.7
(37) Specialist olives	154.0	71.6	-36.4	0.6
(38) Permanent crops combined	74.6	38.8	6.3	73.0
(45) Specialist milk	64.2	54.7	45.5	89.9
(48) Specialist sheep and goats	-10.1	-22.1	-22.7	-15.7
(49) Specialist cattle	31.4	22.1	-4.0	29.9
(50) Specialist granivores	146.1	116.2	82.7	110.6
(60) Mixed crops	37.9	23.9	20.6	24.8
(70) Mixed livestock	264.3	252.3	150.6	187.2
(80) Mixed crops and livestock	31.6	21.4	-5.0	18.5
All	61.4	42.2	32.4	46.0

Source: Authors calculation

During the observed period (2004 - 2021) increase of total fixed assets could be noticed, but decreasing participation of buildings in fixed assets is also present (for an average farm) (Fig. 2).

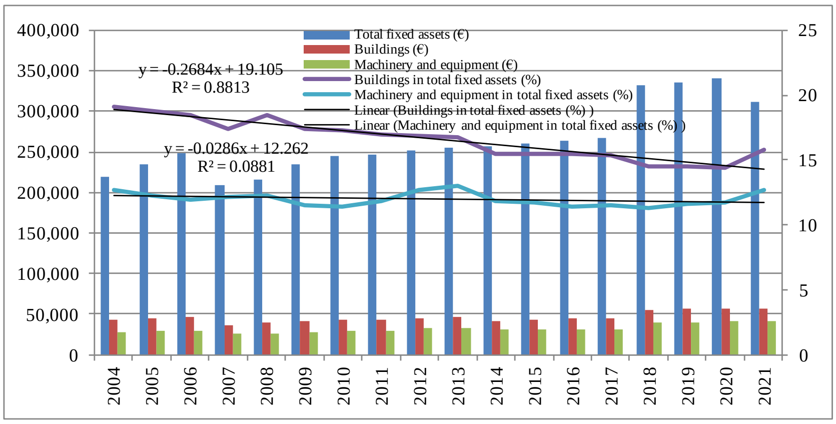

Fig. 2 Value of different assets (EUR) and participation in value of fixed assets (%)
Source: FADN public database and authors calculation

Similar tendecies (but with less pronounced decline) are determined for participation of machinery and equipment in fixed assets of an average EU farm.

More detailed analysis performed for 14 farm types in year 2021 revealed that buildings generally have higher participation in fixed assets (Fig. 3), except for specialized COP farms, farms specialized in production of other fieldcrops, specialized orchard – fruits, specialized olive producers and permanent crops combined.

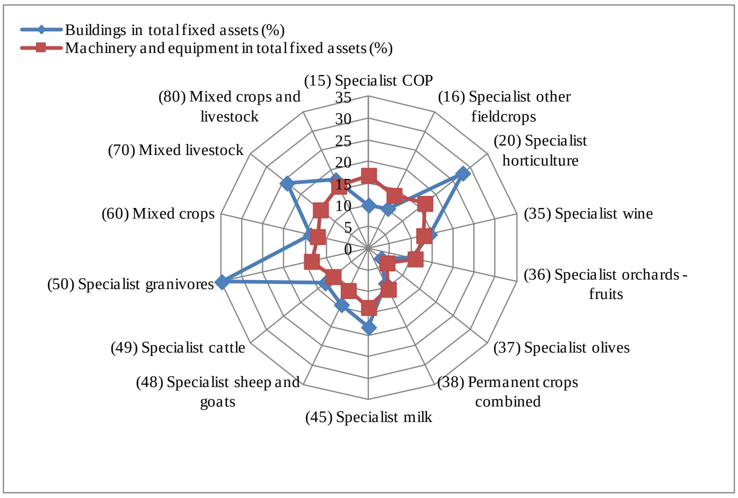

Fig 3. Participation in total fixed assets for TF 14 in 2021
Source: Authors calculation

When it comes to costs, this research is primarily devoted to machinery and building current costs, energy costs and costs of contract work. Sum of all these costs (for an average EU farm) has rather small participation in total inputs (total costs) – during the observed period it was usually under 20% (Fig. 4). Nevertheless, increasing trend of their importance in total costs could be noticed.

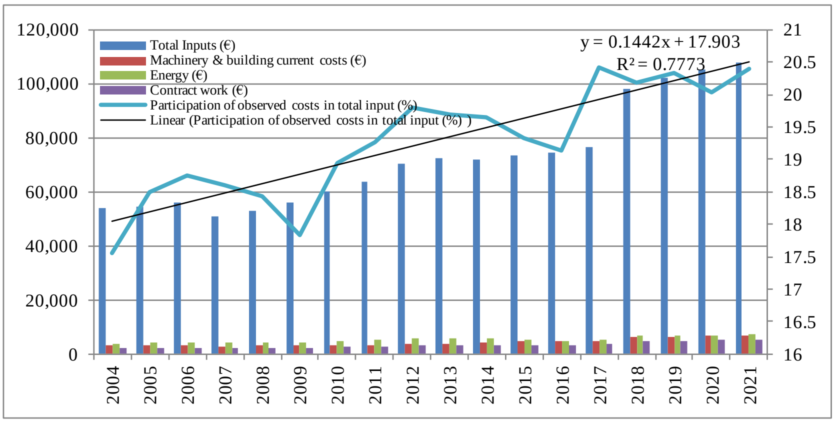

Fig. 4 Amount of certain costs (EUR) and their participation in total inputs (%)
Source: FADN public database and authors calculation

More detailed analysis (per various farm types) on the basis of the data for year 2021 revealed that energy costs are dominant (for 10 out of 14 farm types). Machinery and building current costs are dominant for three farm types (specialist milk, specialist cattle and mixed livestock production), while costs of contract work dominate for farms specialized in wine production (Fig. 5). Therefore, for majority farm types the attention should be primarily paid to energy costs.

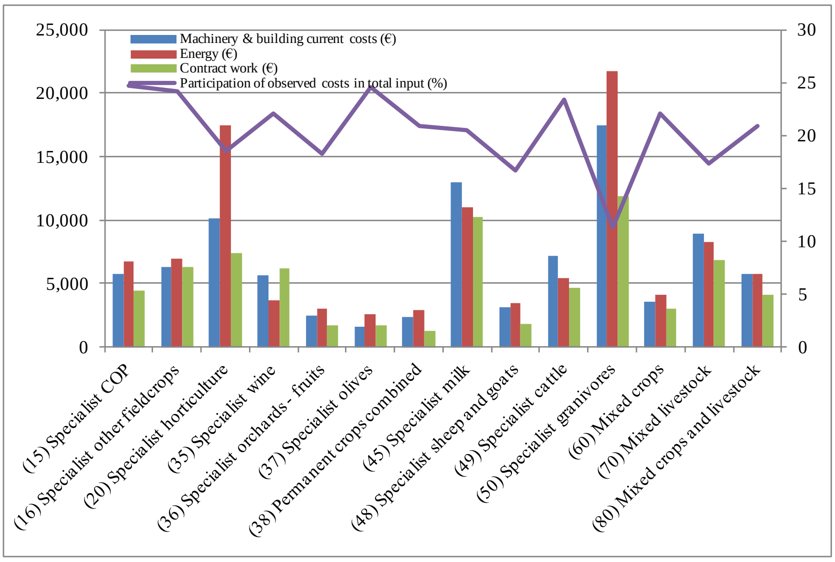

Fig. 5 Amount of costs (EUR) and their participation in total input (%) in 2021
Source: FADN public database and authors calculation

At the same time, sum of observed costs (SE340, SE345 and SE350) participate in total input from 11.36% (specialist granivores) to 24.75% (specialist COP production) (Fig. 5). The results lead to the conclusion that the biggest farms (specialized in granivores breeding) have the higher absolute amount of observed costs. On the other hand, relative importance of costs in question is the higher for specialized COP farms and farms specialized in other fieldcrops (apart from specialized olives production, which is irrelevant for Serbian production conditions).

All 14 farm types experienced cumulative growth (2004-2021) of total inputs (the higher for mixed livestock farm type) (Table 2). Even higher cumulative growth is observed for costs, while (in average) the most important growth was recorded for costs of contract work. The higher increase of all the observed costs is noticeable for mixes livestock type of production, while specialized sheep and goat farms had the lowest growth rates. More elaborate analysis of EU livestock production (primarily sheep and goat farms) based on FADN data were performed by Nastić et al. (2017a) and Nastić et al. (2017b).

Table 2 Cumulative growth of costs for various farm types (%)

14 Types of Farming	Cumulative growth (2004-2021) (%) Total Inputs	Machinery & building current costs	Energy	Contract work
(15) Specialist COP	30.3	49.5	54.8	37.5
(16) Specialist other fieldcrops	37.4	49.9	65.9	65.1
(20) Specialist horticulture	64.4	118.3	43.8	163.5
(35) Specialist wine	51.8	80.6	123.0	226.9
(36) Specialist orchards - fruits	88.9	105.7	137.5	143.4
(37) Specialist olives	165.1	201.1	224.4	251.0
(38) Permanent crops combined	147.6	200.4	225.0	162.8
(45) Specialist milk	113.2	129.6	141.0	129.9
(48) Specialist sheep and goats	24.1	15.3	68.4	7.4
(49) Specialist cattle	39.4	64.9	85.1	51.2
(50) Specialist granivores	186.8	183.0	181.3	193.8
(60) Mixed crops	75.5	140.8	99.0	122.6
(70) Mixed livestock	338.5	399.6	284.2	351.6
(80) Mixed crops and livestock	42.0	68.9	52.0	61.9
All	99.4	112.4	104.0	123.0

Source: FADN public database and authors calculation

Having in mind that (among analyzed costs) energy costs are the most interesting for agro-food sector, special attention should be paid to energy efficiency. According to Diakosavvas (2017) energy efficiency assumes "using less energy to provide the same level of output and services". Discussing energy efficiency in entire agriculture author assumed that it is "the ratio of agricultural GDP per unit of direct use of energy". In the more comprehensive research (based on FADN data) discussing energy costs on the EU farms (conducted by Martinho, 2020a) total production was discussed as an output, while several inputs were observed (hours of paid labour, value of fixed assets and energy costs). Martinho, 2020b) also considered relations between farm output and energy costs, discussing possible redesign of CAP. Having above mentioned in mind, energy efficiency in this research is established as a relation between total output of farms (SE131) and their energy costs (SE345). Nevertheless, it should be noticed that such indicator does not take into account indirect energy used at the farm. Besides, there could be some other indicators of energy use, such as energy use per hectare or energy use per fattening pig equivalent (Meul et al., 2007), specific energy input, energy ratio, energy productivity, and net energy gain (Dimitrijević et al., 2020) and alike.

Detailed analysis of energy efficiency during period 2004 – 2021 for all 14 farm types (as well as for average EU farm) including trends of energy efficiency is presented on Fig. 6.

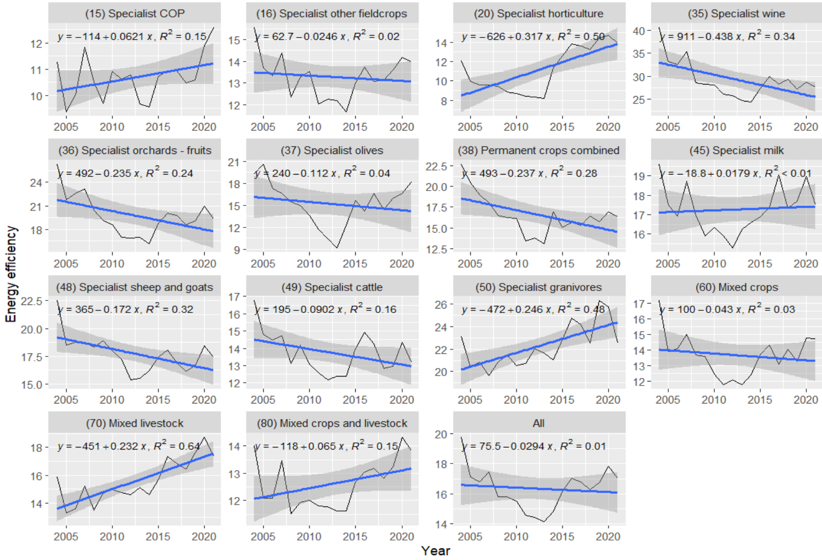

Fig. 6 Trends of energy efficiency for various farm types
Source: FADN public database and authors calculation

While average of all farms indicate slightly decreasing trend of energy efficiency, there are some farm types having much favorable trends. To have better insight in this problem, energy efficiency is discussed for year 2021 for all farm types (Fig. 7).

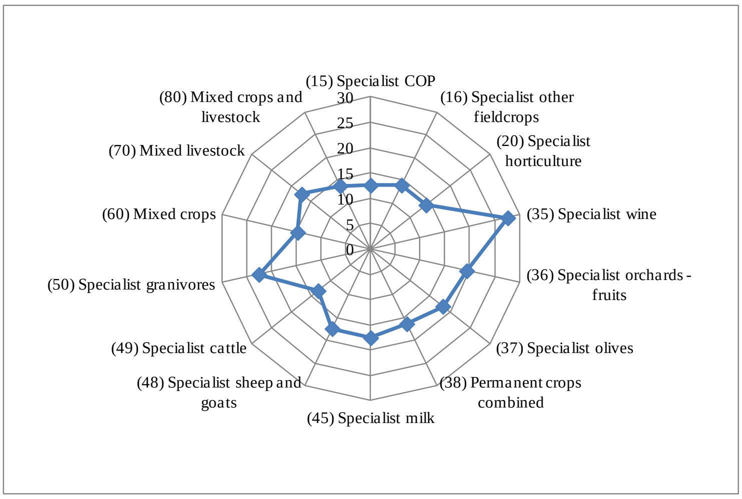

Fig. 7 Energy efficiency of observed farm types in year 2021
Source: Authors calculation

The highest energy efficiency is recorded for farm specialized in wine production, followed by specialist granivores. On the other side, the lowest level of energy efficiency is attributed to specialist COP farms, while slightly better results are determined for specialist cattle, mixed crop and livestock, specialist horticulture and specialist other fieldcrops.

CONCLUSION

Agriculture of the EU can be analyzed from various perspectives using FADN data. One of the most common ways is to discuss farms performance according their production type. Although there were some research devoted to costs of buildings, machinery and equipment, they are primarily related to energy costs. On the other hand costs of current upkeep of equipment and buildings, as well as costs of contract work are less discussed. Nevertheless, the results of this research indicated that for some farm types farming overhead costs are dominated by costs of contract work (farms specialized for wine production) while energy costs are rather low. Therefore, specialist wine farms have the best performance concerning energy efficiency analysis.

Besides, there are three farm types which overhead costs are dominated not by energy costs, but by machinery and buildings current costs. Such farms are dealing with livestock production, predominantly some types of cattle breeding (specialist milk, specialist cattle and mixed livestock production).

If we discuss the sum of all observed costs (energy, contract work, current upkeep of building and machinery) their participation in total costs is the highest for specialist COP farms. At the same time, specialized COP farms have the lowest level of energy efficiency. These farms are also characterized by much higher participation of machinery in total fixed assets, comparing to participation of buildings. Having in mind that specialized COP farms (producing cereals, oilseeds and protein crops) are the most numerous farm types in the EU, they should be in focus of future research in this field. Similar direction of research should be recommended for Serbian agriculture, concerning importance of cereals, oilseeds and protein crops production for Serbian agriculture.

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