ASSESSING THE ECONOMIC SUSTAINABILITY OF SERBIAN FARMS BASED ON FADN DATASET

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Abstract

The main goal of this paper is to explore economic sustainability of all farm types in Serbia. Number of farms in Serbia decreasing sharply, with 10% rate in period 2012-2018. Economic sustainability is just one dimension of farm sustainability, beside social and ecological dimensions. Knowing that, research is conducted taking in account farmers point of view, where economic results of farm business is baseline for decisions about farm future. Economic sustainability is first element in focus of farmers, especially when social responsibility is not adequate. Time scope of research is production year 2018. Analysis revealed types of farming, economic size classes and regions that had better economic viability. Farms in north Serbia region from all types of farming scored better technical efficiency results. The most efficient types of farms are poultry and horticulture, while on opposite side worst technical efficiency scored dairying, vineyards and grazing livestock types of farming. Results for 2018 are in line with results for previous 2017 year.

Kay words: FADN, farm, sustainability, profitability, efficiency, Serbia.

Introduction

Latest Census of agriculture 2012, followed by Farm structure survey 2018 revealed sharp decrease for 10% of farms number in Serbia (Statistic office of Serbia, 2019a,c). In farm structure dynamic of changes is significantly higher. For example, in dairy production farm number decreased from 154 to 116 thousands, every fourth farm sized milk production. At same time number of crop farms remain more stable.

Structure of farms according economic size measured in Standard output (SO) changes in the way that highest decrease comes from the group of small farms with up to 4,000 EUR of SO, almost equally in both regions Serbia

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North and Serbia South. Other size groups of farms increased in number indicating that remaining farms increased resources and value of production, and since that moved to bigger size group.

Future changes in farm structure will be influenced by several factors as: labour aging, farm succession process, legal boundaries, economic sustainability etc. To discover trends in farm structure changes and to predict results, field research data are essential.

One of powerful databases for analysis of economics results of farms and to understand its economic sustainability is Farm Accountancy Data Network (FADN). Process of establishing FADN system in Serbia started in 2011. Organised by Ministry of agriculture, forestry and water management FADN in Serbia is realised by field work of Serbian extension service. Farm sample size and quality and reliability of data is improving from year to year. In 2018 number of farms in sample increased to 1,653 from 1,420 farms in previous year. Numerous variables (above 1,000) in FADN databases enable to understand economic aspects of farm production across regions in Serbia, by farm production types and by farm sizes.

Sustainability of farms is usually measured trough three dimensions: economics, social end ecological sustainability. Previous researches of farm sustainability in Serbia (Popovic, Knezevic, 2011; Popovic et al. 2011) proved that sustainability of small sized dairy farms is endangered. In sustainability concept it is not possible to construct unique indicator and all three dimensions are equally important (Shadbolt, Martin, 2005). From farmers point of view economic dimension of sustainability have to be achieved to keep farm in the business.

Material and methods

All European Union countries as well as countries candidates, through the FADN collects and processing technical, financial and economic data. In EU over 80,000 agricultural holdings in FADN sample represent population about 5,000,000 and cover 90% of utilized agricultural land and 90% of total agricultural production. This instrument provides data on income and economic activities on agricultural holdings. FADN enables the EC to monitor the economic situation of agricultural holdings in the EU (European Commission, 2019).

The main purpose of this data is used for analyzing, development and evaluation of Common Agricultural Policy (CAP) measures. Implementation of the FADN is the responsibility of Member State which shall nominate the Liaison Agency that collects data and transmits it to the EC and the National Committee to supervise the implementation of the FADN system.

Idea of FADN and its legal basis are established in 1965. Current implementation of FADN in the EU is defined by the following regulations Council Regulation No 1217/2009, Council Regulation No 1318/2013, Commission Delegated Regulation No 1198/2014 and Commission Implementing Regulation 2015/220.

FADN is the only EU instrument that collects detailed financial data from farms so it is therefore an important source of information for decisions on agricultural policies. The dissemination of FADN results are based on "Standard Results" generated on the basis of validated and aggregated FADN Farm Returns and checked by the European Commission.

The standard results are a set of statistics, computed from the Farm Returns that are periodically produced and published by the Commission. Data are public and available in a Public Database. They describes detailed economic situation of farmers by different groups throughout the European Union (Kovacevic, Bojcevski, Krasavac, 2017).

The type of farming of the holding is defined using the shares of various types of activity in the total Standard Output established for the holding. The type of farming reflects the production system of the holding. Depending on the desired level of accuracy, the types of farming of agricultural holdings are divided into:

1. 8 general types and a group of non-classified holdings (labelled with one digit), usually used for comparison on EU level
2. 21 principal types and a group of non-classified holdings (labelled with two digits),
3. 61 particular types and a group of non-classified holdings (labelled with three digits).

A detailed typology has been created for use by various bodies at European Union level. It is sufficiently broad to encompass the many different types of farming that are found in the European Union. Types of farming are defined in terms of the relative importance of the different enterprises on the farm. Relative importance is itself measured quantitatively as a proportion of each enterprise's SO to the farms' total SO.

Different Types of Farming (TF) at the level of the European Union are shown in the tables 1 and 2. TF 10 in Serbia are defined according needs of Ministry of agriculture, forestry and water management, but this classification is suitable to TF 8 (Table 2).

Table 1. Type of farming in EU by two classification.

General TF		TF 14	
1	Specialist field crops	15	Specialist cereals oilseeds and protein crops
2	Specialist horticulture	16	Specialist other field crops
3	Specialist permanent Crops	35	Specialist wine
4	Specialist grazing livestock	36	Specialist orchards - fruits
5	Specialist granivore	37	Specialist olives
6	Mixed cropping	38	Permanent crops combined
7	Mixed livestock	45	Specialist milk
8	Mixed crops-livestock	49	Specialist cattle
9	Non classifiable	48	Specialist sheep and goats
		20	Specialist horticulture
		50	Specialist granivores
		60	Mixed crops
		70	Mixed livestock
		80	Mixed crops and livestock

Source: European commission, FADN https://ec.europa.eu/agriculture/rica/detailtf_en.cfm?TF=TF14&Version=13185

The National FADN committee of Serbia adopted criteria for FADN field of survey:

1) Two regions Serbia North and Serbia South
2) Economic size threshold 4,000 EUR
3) 10 general Types of Farming,
4) 14 economic size of holdings,
5) Based on 2012 Agriculture Census FADN sample should consist of 2,000 households.

According Agriculture Census 2012 only one third of all farms in Serbia had higher SO than threshold of 4,000 EUR. Looking from result side, those farms used approximately 90% of the total utilised agricultural area (UAA) and accounted for about 90% of the total agricultural production. Farm structure survey in 2018 revealed that about one half of farms had size above established threshold.

Table 2. Type of farming in EU by TF 8 and adjust of TF 10 in Serbia

TF 8 - EU		TF 10 - Serbia	
1	Fieldcrops	1	Field crops
2	Horticulture	2	Horticulture indoor
		3	Horticulture outdoor
3	Wine	4	Vineyards
4	Other permanent crops	5	Fruits
5	Milk	6	Dairying
6	Other grazing livestock	7	Grazing livestock
7	Granivores	8	Pigs
		9	Poultry
8	Mixed	10	Mixed

Source: European commission, FADN, and FADN Serbia

Economic sustainability of TF 10 in Serbia is estimated through several dimensions. First one is technical efficiency measured as ability of farms to use as less as possible resources to produce one unit of output. Efficiency is mostly used to understand level of competitiveness among farms with different types of farming.

In this research assessment of farms technical efficiency is based on the input-oriented Data envelopment analysis (DEA) method with variable return to scale (VRS), developed by Banker et al. (1984). Method with constant return to scale (CRS) developed earlier by Charnes (1978) have some disadvantages compared with VRS method. The DEA method with VRS has advantages over a model with a CRS in conditions where imperfect competition exists. This cause a situation in which companies do not operate at the optimum level or size (Coelli et al., 2005). Ratio between CRS and VRS represent efficiency of size for each farm.

Relative technical efficiency is measured for individual farms in the sample of 1653 farms in two Serbian regions. Each farm is analysed as separated Decision Making Unit (DMU) and compared in relation each farm to all other. All values of estimated farm efficiency by CRS and VRS are in range between 0 and 1, while value of 1 represent efficient farm. Value of size efficiency coefficient equal to 1 indicate optimal farm size. Otherwise, values lower than 1 indicate inadequate size of farm where it can be oversized or undersized.

Software applied in this paper to assess technical efficiency of farms is DEAP Version 2.1 developed by Tim Coelli (1996).

Second dimension in analysis of farm economic sustainability is productivity. By definition productivity is ratio of the output(s) that it produces to the input(s) that is used (Coelly et al., 2005). It is absolute indicator and can be calculated as total factor productivity, that ask for aggregating all outputs into one single index of outputs and aggregating all inputs into one single index of inputs. Most often in use are partial productivity measures as are for example labour or land productivity.

Productivity of farms is in this research is estimated as labour productivity measured as ratio of total output corrected for balance of current subsidies and taxes, and annual work units (AWU) used at farm. As output measure is chosen money value of farm output realised from farm business in period of one year.

Profitability is third dimension of farm economic sustainability. It is measured as net farm income per annual work unit. Net farm income is a measure of return to the equity capital, unpaid labour, and management contributed by the owner/operator to the farm business (Kay et al. 2008).

In economic cost concept net farm income is constituted from opportunity cost and economic profit. On family farms significant share of net farm income is return to resources owned by farmer: family labour, management and capital. In Serbia 99,7% of all farms are family farms.

Results

The economic sustainability is often analysed in literature. Historically, scientific attention at beginning of XX century was focused on profitability and productivity of farms. Since Farrell (1957) constructed concept of economic efficiency measurement, numerous researches arise in that area (Banker et al. 1984, Charnes et al. 1978, Coelly et al. 2005, Ruggiero 2005, Sarkis 2007, Kay et al. 2008, Bojnec, Latruffe 2008, Fogarasi, Latruffe 2009, Balezentis, Krisciukaitiene 2013, Kocisova 2015, Popovic et al. 2018, etc.). DEA method was most exploited in researches focussed on farms and other subjects in agribusiness sector.

Five variables chosen for DEA model embrace all output and input side of farm business. In case of family farms where is level of specialisation low it

is not easy to define single unique output measure. Higher specialisation is noticed in case of several farms with TF poultry and pigs production. Those farms do not own agricultural land and buy on the market all feedstuff. That is why for this purpose output variable is defined as value of production corrected for balance of current subsidies and taxes. It is money value representing unique result of farm activities in one year, from which farmer cover all incurred costs of inputs.

On input side four variables are chosen for DEA model: total intermediate consumption (in RSD), labour input (hours/year), total fixed assets (in RSD) and total utilised area (ha). Total intermediate consumption covers total specific crop and livestock costs and overheads arising from production in the accounting year. It is most important group of cost with typically highest share in all accounting costs. Labour input includes total number of family and non-family working hours on farm per year. Total fixed assets includes value of very diversified quantity and quality of fixed resources on farms. Last input variable is total utilised agricultural area, including owned and rented land expressed in hectares.

In Table 3 is analysed descriptive statistics for one output and four inputs variables used in DEA method for Serbian farms in 2018. There is huge variation among farm data, since farm sample cover wide range of farms size from 4,000 EUR SO to more than 3,000.000 EUR SO.

Table 3. Descriptive statistics for variables of 1653 DMU, used in DEA method.

Variable	**Unit**	**Average**	**Standard deviation**	**Minimum**	**Maximum**
Value of production + subsidies -taxes	RSD	6,649,420	10,322,297	51,000	164,962,000
Total intermediate consumption	RSD	2,702,699	4,264,277	73,000	78,426,316
Labour input	hour/ year	3,629	2,823	100	64,800
Total fixed assets	RSD	16,827,059	21,683,425	332,500	261,476,001
Total utilised agricultural area	ha	27	42	0	549

Source: FADN Serbia database 2018.

Data in Table 4 uncover correlation relationship between input and output variables. Strong correlation exist between output variable and total intermediate consumption. Additionally, value of production corrected with balance of current subsidies and taxes is significantly correlated with two

other input variables: total fixed assets and total utilised agricultural area. Total intermediate consumption is correlated with total fixed assets and total utilised agricultural area. Significant correlation exist in relationship total fixed assets and total utilised agricultural area. Typically the highest share of total fixed assets is value of owned land area. It approve that most of used agricultural area on farm is owned by farmers. Weak correlation is noticed only in case of labour input with other four variables. In recent decades farmers adopt whole range of new labour saving technologies what explains low correlation.

Table 4. Correlation analysis of input and output variables for 1653 DMU.

	Value of production + subsidies - taxes	Total intermediate consumption	Labour input	Total fixed assets	Total utilised agricultural area
Value of production + subsidies - taxes	1				
Total intermediate consumption	0.815	1			
Labour input	0.446	0.375	1		
Total fixed assets	0.593	0.566	0.246	1	
Total utilised agricultural area	0.624	0.623	0.172	0.703	1

Source: Estimate based on variables from FADN database

Estimated technical efficiency of TF 10 Serbian farm based on input-oriented DEA model with VRS are presented for two regions North and South in Tables 5 and 6. Results for farms in Serbia North region revealed variation in efficiency by different TF. The higher technical efficiency generated: poultry (0.543), followed with horticulture, pig and fruit producing TF.

On the other side, the lowest efficiency is encountered by dairying farms (0.229), what explain the biggest decrease in number of dairy farms. Four other TF that generate under average technical efficiency are: field crops, mixed crops and livestock, vineyards and livestock production with grazing livestock.

Average technical efficiency of farms in North region (0.322) is higher than in South region (0.255). Besides that, all TF in North region reached higher technical efficiency comparing with TF in South region. It was expectable, because of better resource structure on farms in North, followed by differences in applied technologies in crop and livestock enterprises.

Table 5. Technical efficiency scores by DEA method of farms in North Serbia regions for 2018.

	DMU	CRS	VRS	Scale efficiency	Efficiency rank
Field crops	346	0.193	0.317	0.639	6
Horticulture indoor	7	0.305	0.490	0.627	2
Horticulture outdoor	12	0.239	0.451	0.446	3
Vineyards	4	0.085	0.276	0.350	8
Fruit production	51	0.151	0.339	0.457	5
Dairying	28	0.156	0.229	0.703	10
Livestock production - grazing livestock	12	0.122	0.265	0.477	9
Pigs production	7	0.115	0.355	0.369	4
Poultry	25	0.337	0.543	0.581	1
Mixed crops and livestock	91	0.145	0.280	0.586	7
Total:	583	0.185	0.322	0.603	

Source: Estimate based on DEAP software and FADN Serbia database

Table 6. Technical efficiency scores by DEA method of farms in South Serbia regions for 2018.

	DMU	CRS	VRS	Scale efficiency	Efficiency rank
Field crops	181	0.106	0.259	0.424	6
Horticulture indoor	16	0.160	0.258	0.639	7
Horticulture outdoor	29	0.191	0.324	0.521	2
Vineyards	7	0.109	0.195	0.564	10
Fruit production	139	0.097	0.284	0.372	4
Dairying	312	0.083	0.220	0.402	9
Livestock production - grazing livestock	113	0.087	0.245	0.390	8
Pigs production	32	0.159	0.285	0.563	3
Poultry	32	0.203	0.331	0.597	1
Mixed crops and livestock	209	0.110	0.266	0.402	5
Total:	1070	0.105	0.255	0.419	

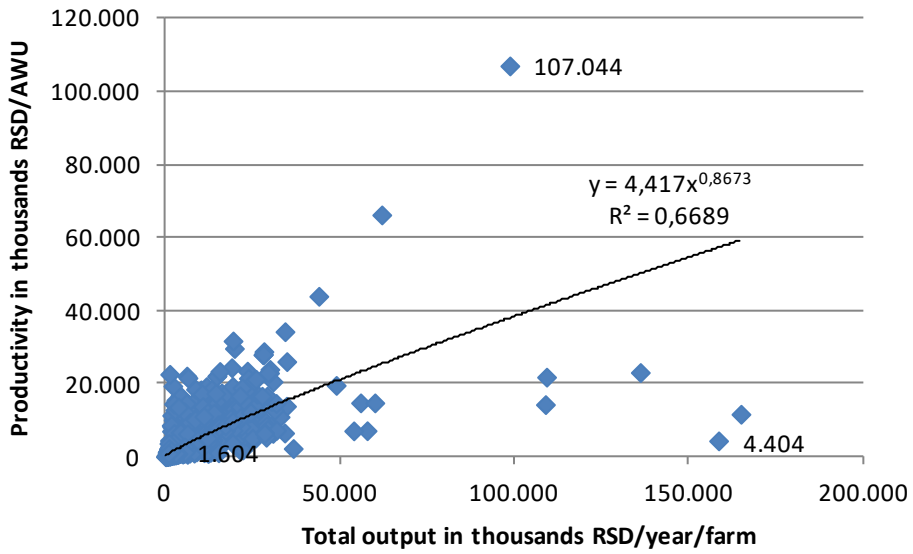
Source: Estimate based on DEAP software and FADN Serbia database

Scores of technical efficiency of TF in Serbia South region in 2018 (Table 6), are generally lower but in similar formation as on North region. Only exceptions are two TF: horticulture indoor and mixed crops and livestock that exchanged position in relation to average technical efficiency. The best positioning TF are poultry and horticulture outdoor production. Two the worst technically efficient TF are dairying and vineyard production.

Results of previous research of farm technical efficiency in Serbia for 2017 are in the line with this results (Popovic et al. 2019).

Partial productivity of 1,653 farms in FADN 2018 sample is presented in Graph 1. Productivity per AWU depends from farm size measured in total output. Coefficient of determination R^2=0.67 in regression explains that partial labour productivity expressed in RSD per AWU depends from size of farm business. The higher size of farm, cause the higher labour productivity. New labour saving technologies are faster adopting by middle and big sized farms, while small farms traditionally depends on labour.

Graph 1. Labour productivity of 1653 farms in Serbia in 2018, distributed by farm size.

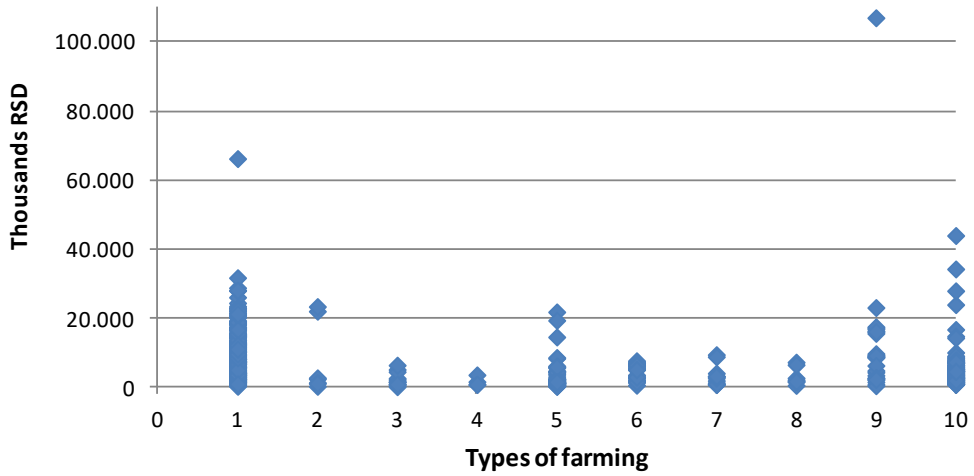


Source: Estimate based on variables from FADN database

Differences in labour productivity per TF 10 in Serbia North region is presented in Graph 2. Distribution of labour productivity revealed stronger

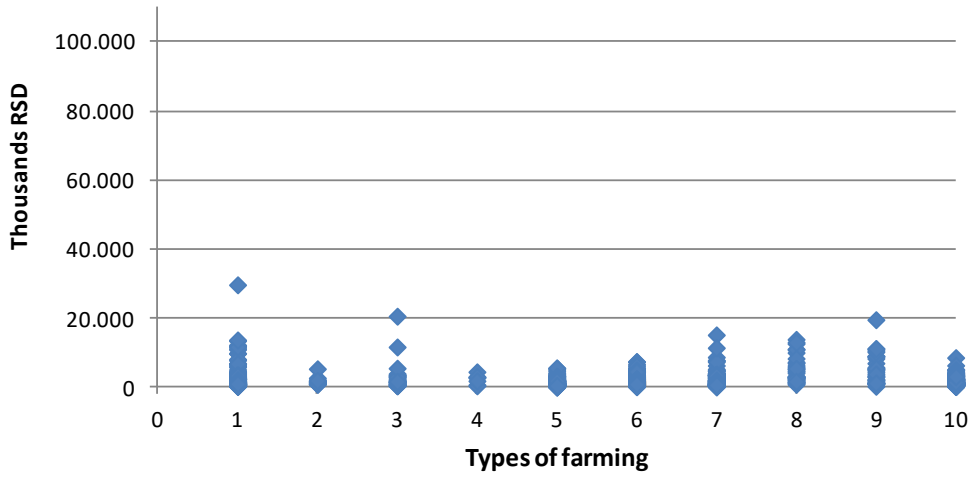
variation among TF 10. Higher levels of labour productivity reached some farms with crop production, mixed crop and livestock production, poultry, fruit and horticulture production. Contrary, the lowest level of productivity realised by vineyard, dairying and pigs production types of farming.

Graph 2. Labour productivity of 583 farms in Serbia North in 2018, distributed by 10 types of farming.



Source: Estimate based on variables from FADN database

Graph 3. Labour productivity of 1,070 farms in Serbia South in 2018, distributed by 10 types of farming.



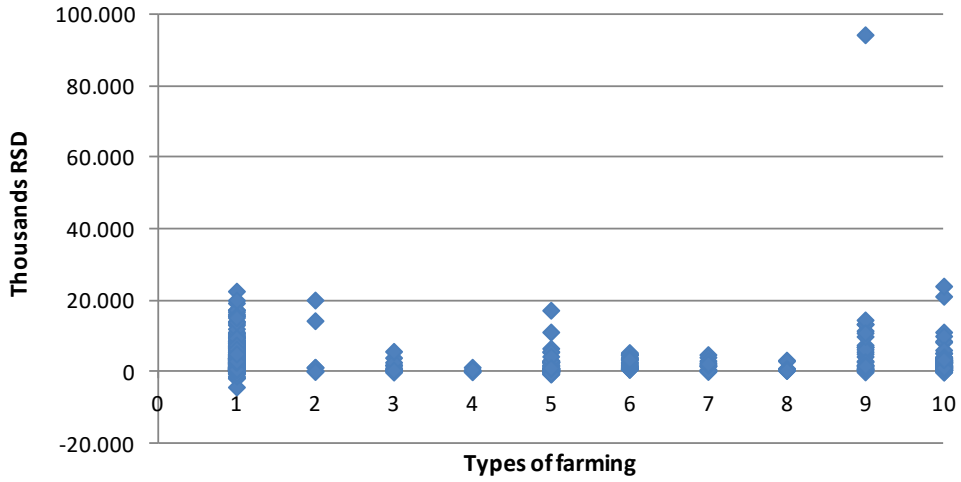
Source: Estimate based on variables from FADN database

Labour productivity distribution by TF in Serbia South (Graph 3) is lower and less variable than on farms in North of country. It is especially pronounced in case of four TF: crop, horticulture indoor, fruit and mixed crop and livestock production. Three TF: horticulture outdoor, livestock production - grazing livestock and pigs production had wider range of labour productivity.

During production 2018 year weather conditions were average, and production results had to be treated in that way. Drought condition during previous 2017 year decreased crop production and lowered feed production that could have negative production and financial effects in some livestock farms during 2018.

Although 2018 can be treated as normal production year, about 95% of all farms in FADN sample reached profit, while 5% of farms realised loss in farm business. From economic cost concept view profitability situation was strongly different. Remuneration for family owned resources as it is labour and capital cause high opportunity costs. Since majority of farms in Serbia are family farms and relying usually only on family labour and own capital economic profit is negative in case of those farms that operate with lower accounting profit.

Graph 4. Profitability of farms in Serbia North in 2018, distributed by 10 types of farming.

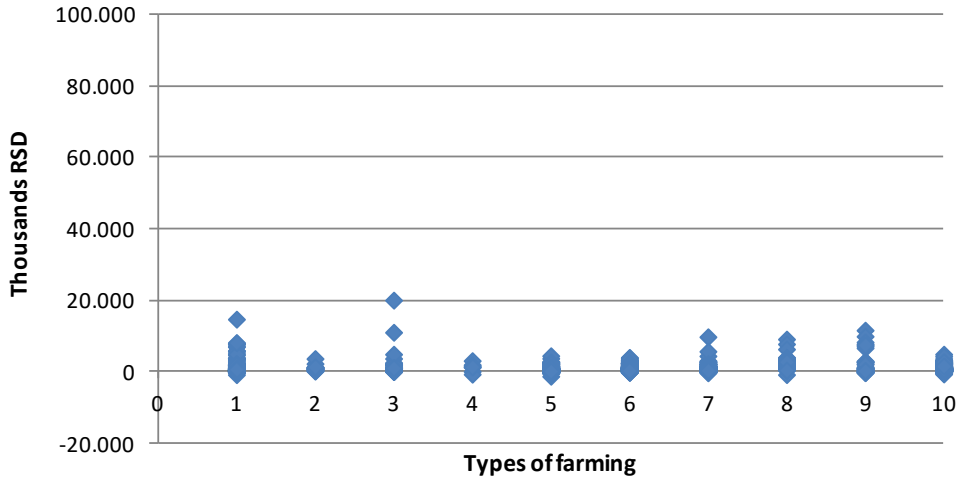


Source: Estimate based on variables from FADN database

Farm profitability measured in farm income per AWU and distributed per TF 10 is presented in Graph 4. The most numerous type of farming in Serbia

North region are crop farm. Few farms in crop TF encountered highest negative financial results in whole farm sample. At same time, some farms in crop TF, as some farms in horticulture, fruit, poultry and mixed crop and livestock production reached the highest profits, comparing with farms in South region. Farms in other TF remain on lower level of profitability per AWU.

Graph 5. Profitability of farms in Serbia South in 2018, distributed by 10 types of farming.



Source: Estimate based on variables from FADN database

Farms in Serbia South region (Graph 5) realised significantly lower profits per AWU. Although, number of farms in sample for this region is almost double than in North region, at same time farms are smaller and profitability distributions per TF had more narrowed range. Comparing with farms in North region some farms in South region with TF as: horticulture outdoor, vineyards, livestock production-grazing livestock and pigs production encountered higher profitability.

Conclusions

Structural changes speed up in the Serbian farm sector. Total number of farms decreased in 6 years period for 10%. Inside types of farming structure changes are even more dramatically. Every fourth dairy farm disappeared in the same time frame. Mostly small farms ceased business, but in some cases it happenings also in range of middle and bigger sized farms. Farms

remaining in business constantly increase resources and adjusting to more prospective types of farming.

Economic sustainability of farms based on FADN dataset, measured by three dimensions: technical efficiency, productivity and profitability reveal some answers about farm structure changes. Assessed average technical efficiency of 10 types of farming indicate that farms in Serbia North are more technically efficient than farms in Serbia South region. Variation of technical efficiency coefficients among types of farming is significant. The most technically efficient types of farming in both Serbian regions in 2018 was: poultry and horticulture. Contrary, two the most inefficient types of farming were: dairying and vineyard production. Results are in the line with findings for previous 2017 year, what partially explained why farm structure changes are most intensive in dairy sector and especially in Serbia South region.

Analysis of FADN data in sample indicated that labour productivity depends of farm business size. Bigger farms have higher labour productivity measured per annual work unit. Bigger farms are dominantly located in Serbia North region, what influence regional productivity differences. Labour productivity is much higher in Serbia North region in most types of farming except: pigs production, vineyard and horticulture outdoor production.

Farm profitability analysis disclosed that some farms in Serbia North region reached higher profitability per AWU. It is noticeable in crop, horticulture, fruit, poultry and mixed crop and livestock production. Exceptions are some farms in South region, oriented in vineyard, livestock production-grazing livestock and pigs production types of farming that earned higher profit.

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