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EQUIPMENT OF FAMILY FARMS WITH AGRICULTURAL MECHANIZATION IN NORTHWEST OF MONTENEGRO

SUMMARY

The paper presents the results of testing equipment at family farms with agricultural machinery in Northwest Montenegro in municipalities Pljevlja, Žabljak, Kolašin and Mojkovac. In the mentioned municipalities, 123 agricultural farms in 65 villages were surveyed. The total area of available land on farms is 1612.08 ha, of which only 8.27% are cultivated and the rest meadows and pastures. The average area of family farms is 13.11 ha of used agricultural land, which is three times more than the average in Montenegro. Single-axle tractors with an engine power of 5-10 kW are represented by 16% of the total number of tractors. Family farms are not sufficiently equipped with two-axle tractors, because every other one has a tractor (0.51 tractors per farm). The tractors are average power of 30.12 kW. Energy equipments in the surveyed area, expressed through the nominal engine power of two-axle tractors per unit area, in averages at 1.18 kW / ha.

There's a shortage of tractors with engine power over 50 kW with rear and front wheel drive (double traction). Family farms are insufficiently equipped with attached machines (1.28 machines / farm). Ratios per one two-axle tractor are 2.49 attachments and 10.27 ha of used land. There is a lack of machines for vertical tillage and combined machines for pre-sowing soil preparation (chisel plows, seed drills, rotary harrows), as well a seeder for small grains and corn. In addition, there is a lack of machines for the preparation of silage and haylage in silage facilities (self-loading trailers and combines), as well roll presses, wrappers and catchers wrapped in foil.

Keywords: size, equipment, farms, tractors, attachments, energy equipment.

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INTRODUCTION

Sustainable functioning of agricultural family farms depends on their equipment with agricultural machinery, but also on the available human labor. Unfortunately, the working age population, especially the younger are increasingly missing in the countryside. It is necessary to facilitate and mechanize work processes and the application of agro-technical measures.

Rural aging is a common occurrence and is found in many countries, regardless of economic development (Veljković *et al.* 2020). In Montenegro, the labor force is becoming a limiting factor in the development of agriculture and revitalization of family farms, because 44% of the total number of people working in agriculture is older than 55 years (Šarović, 2014). Thus, the intensive development of agriculture is largely limited by the insufficient equipment of family farms with agricultural machinery and the lack of labor force. According to the 2010 census in Montenegro, agricultural production takes place mainly on 5265 family farms, on an area of 294400.7 ha of available land (Statistical Office of Montenegro, 2011). In the examined area, family farms are engaged in livestock production, while crop production is mainly for the needs of animal feed (meadow hay and cereals).

The aim of the research is to determine the equipment of family farms with agricultural mechanization based on the analysis of the existing situation and to give recommendations for the necessary mechanization.

MATERIAL AND METHODS

The survey of agricultural family farms was conducted in the Northwest part of Montenegro in the territory of municipalities Pljevlja (41 willages, 71 farms), Žabljak (14 willages, 16 farms), Kolašin (2 willages, 18 farms), and Mojkovac (8 willages, 18 farms). Villages and farms were selected for the survey by random sampling. In this 4 municipalities, a total of 123 agricultural farms in 65 villages were surveyed. The researchers used the interview questionnaire to record data on farm size, available areas (arable land, meadows and pastures), number, power, age, types and manufacturers of tractors, as well as the number and type of attachments. After the survey, the data were grouped, processed and presented in tables and graphs. The technical equipment of farms with the effective power of tractors per unit of agricultural area in the surveyed area is defined by the expression:

$$Et = \frac{\sum_{i=1}^n Pe(i)}{\sum_{i=1}^m Ai} \text{ (kW / ha)}$$

Et – equipment of farms with tractor power per agricultural area
A (ha) – agricultural area
Pe (kW) – effective tractor engine power

In addition to the results of the survey, the paper also used statistical data from the Statistical Office of Montenegro, Document of Cenzus of Agriculture

2010, and Annual statistics of transport, storage and communications 2011-2019. Based on the data collected in the field, the equipment of family farms with mechanization was registered. The number of tractors per farm, arable land per tractor, average tractor power, effective power per hectare, equipment of farms with attachments, number of attachments per tractor and area of used land per attachment were determined.

RESULTS AND DISCUSSION

The investigated area is the Northwest part of Montenegro and occupies 63359.9 ha or 21.52% of the total area of available land, so that one fifth of agricultural production takes place in this part of Montenegro. In all four municipalities, pastures and meadows cover an area of 45951.1 ha or 72.52% of the total land (Table 1). The configuration of the terrain is very diverse, it consists of river valleys, hills, and mostly hills and mountains, so less than 2% of the available agricultural land is cultivated.

Table 1. Land according to the manner of use on family farms by municipalities

Municipality	Total available land ha	Total utilized agricultural area ha			Orchards and Vineyards	Permanent meadows and pastures ha
		All	Arable fields, gardens	Utilised arable land		
Žabljak	9610	7480	6.6	57	0.0	7416.9
Kolašin	14242	8269	116.3	41.4	4.6	8411.7
Mojkovac	10144.8	7873	44.6	29.7	7.5	7779.5
Pjevlja	29363.1	22901.4	159	280	74.4	22343
Total ha for the surveyed area	63359.9	46523.4	326,5	408.1	86.5	45951.1
Share %	21.52	21.87	13.53	11.16	4.99	22.48
Total ha Montenegro	294400.7	212724.4	2412.8	3656.4	1734	204359.4

(Source: Statistical Office of Montenegro 2011, p.107-121)

Table 2. Land areas of surveyed family farms by municipalities

Municipality	Number villages	Number farms	Available land in ha	Arable land		Average farm size in ha
				ha	%	
Pjevlja	41	71	1.044.67	93.29	8.93	14.71
Žabljak	14	16	288	10.95	3.8	18.00
Kolašin	2	18	137.96	11.93	8.65	7.66
Mojkovac	8	18	141.45	17.20	12.16	7.86
Total:	65	123	1612.08	133.37	8.27	13.11

(Source: Own research)

Family farms organize production on area 1612.08 ha. The average area of used agricultural land per surveyed farm is 13.11 ha, which is three times more than the average in Montenegro (4.60 ha). The farms with the largest average area are in the mountainous parts of the municipality of Žabljak 18 ha (Table 2). Some family farms in the hilly and mountainous area own over 100 ha of land. These are mostly summer pastures on katuns, which according to the research of Šarović (2014) are over 58% in Northern Montenegro. Farmers in the surveyed area by average land are ahead than farmers in Slovenia, Greece, Serbia, Croatia, Western Turkey where the average farm area is less than 10 ha, and behind Poland, Denmark (Poje, 2016, Koprivica *et al.* 2009, Radivojević, 2014, Juscinski *et al.* 2017, Ozpinar, 2020).

The available agricultural land on farms is little cultivated 8.27% or 133.37 ha and these are mostly gardens and fields in river valleys, on hills and mountain plateaus.

According to the 2010 Census of Agriculture, 5,265 family farms in Montenegro owned 1,654 single-axle tractors up to 10 years of age and 4,036 single-axle tractors over 10 years of age (1.1 single-axle tractors per farm). The total number of two-axle tractors is 4560, of which 123 are owned by business entities (companies, cooperatives, etc.), which is half less (228) than in 1991 (Perošević, 2020). The age structure of tractors is unfavorable, as 52% of tractors are older than 20 years, and 8.4% of tractors are younger than 10 years. Most two-axle tractors have an engine power of 30-60 kW (3522) or 77.23% of the total number. A more precise picture of the number of tractors in Montenegro is given by the fact that in the period from 2013 to 2017, 866 tractors were registered. Registered tractors are older than 25 years, 55.6%. It is positive that tractors up to 5 years of age are represented with 38.16%. Poje (2016) states that 91.8% of registered tractors in Croatia are older than 10 years. The average age of registered tractors is 28.44 years, and in Osijek-Baranja County 20.71 years (Zimmer, 2019). In Slovenia, out of the total number of registered tractors in 2014, 83,291 are older than 12 years. The average age of registered tractors is more than 21 years (Poje, 2016). In Hungary, the average age of tractors in 2013 was 18.3 years, and in 2016 it was around 12 years. Of all tractor categories, 57% are older than 10 years. Tractors under the age of 10 are mostly tractors with a power of more than 60 kW (Kesmarki-Gally and Rak, 2018). In Serbia, in 2010, 95% of tractors were older than 10 years (Radivojević, 2014). In Turkey, 46% of the total number of tractors is older than 25, while in the Western part of Turkey, 88% of tractors are younger than 20 (Ozpinar, 2020).

For easier comparison and assessment of the level of equipment of farms with agricultural machinery, the number of single-axle and two-axle tractors and energy supply per unit area are shown (Tables 3 and 4). In the surveyed area, single-axle tractors with a power of 5-10 kW are 12 -16% of the total number of tractors. In addition to single-axle tractors, the farms also have 63 two-axle tractors, which make up 84% of the total number of tractors (Table 3).

Family farms are not sufficiently equipped with two-axle tractors, because on average, every other farm has a tractor (0.51 tractors per farm). According to the number of tractors per farm, this is more than Hungary (0.25) and Kosovo (0.43), and less than Serbia (0.64), Poland (0.77), Turkey (0.99), Slovenia (1.47), as well as the Croatian Osijek-Baranja County (3.3) (Koprivica et al. 2010, Radivojević, 2014, Poje, 2016, Juscinski et al. 2017, Kesmarki-Gally and Rak, 2018, Zimmer, 2019, Ozpinar, 2020).

Table 3. Number and installed power of tractors on family farms in the surveyed area

Municipality	Number of tractor			Total installed tractor power kW		
	Single-axle	Two-axle	Total	Single-axle	Two-axle	Total
Pljevlja	5	51	56	38.5	1527.5	1.566
Žabljak	3	5	8	38	128.5	166.5
Kolašin	2	3	5	10.3	95.0	105.3
Mojkovac	2	4	6	9.4	146.5	155.9
Total	12	63	75	96.2	1897.5	1993.7

(Source: Own research)

The average energy equipment in the surveyed area is 1.18 kW / ha, the highest in Pljevlja is 1.46 kW / ha, and the lowest in Žabljak is only 0.45 kW / ha. For comparison, in Vojvodina, the energy equipment in the private sector is 3.54 kW / ha, and on one tractor with an average power of 40 kW is 15.83 ha of agricultural land. The use of tractor mechanical power in America is 0.783 kW / ha, in Europe 0.694 kW / ha, in Turkey 2.42 kW / ha, in Kosovo 2.55 kW / ha, in Poland 4.9 kW / ha (Koprivica et al. 2010, Bahattin, 2013, Juscinski et al. 2017). In the southeast part of Hungary, farms up to 4 ha in size are equipped with 1.04 tractors / farms, with an average power of 35.9 kW, 5.08 ha each and 6.86 kW / ha. The farm of 8.1-16 ha has 1.5 tractors with an average power of 84.1 kW for processing 13.26 ha and energy equipment with 3.6 kW / ha (Baranyai et al. 2014).

Table 4. Energy equipment of family farms with tractors in the surveyed area

Municipality	Average tractor power	Energy equipment kW/ha	Number ha/ tractors	Number of tractors / per farm
Pljevlja	29.95	1.46	20.48	0.72
Žabljak	25.57	0.45	57.60	0.31
Kolašin	31.67	0.69	45.98	0.17
Mojkovac	36.62	1.03	35.36	0.22
Average	30.12	1.18	25.58	0.51

(Source: Own research)

In the examined area, the average two-axle tractor with a power of 30.12 kW cultivates 25.58 ha of used land, which is a large area for tractors of this category. In Slovenia there is 4 ha per tractor, in Croatia 5.32 ha, in Poland 6.35 ha, in Serbia 7.13 ha, in Kosovo 14.59 ha, in Turkey 17.78 ha of used land (Poje, 2016, Koprivica *et al.* 2010, Radivojević, 2014, Juscinski *et al.* 2017, Bahattin, 2013).

In the survey, two-axle tractors were divided into 4 categories according to engine power (Figure 1). In terms of the number of tractors, are mostly tractors with rear-wheel drive up to 30 kW (73.02%), among which the IMT 539 tractor dominates with 60.32% of the total number of two-axle tractors. Then are the tractors of the power category of 31-40 kW (19.05%) to which the tractors IMT-542 (17.46%) and Ursus 3512 (1.59%) belong. There is the least tractors with drive four all-wheel (double traction) with engine power over 50 kW (3.17%), one tractor each IMT 577 and Rakovica 75 (Figure 1 and 2).

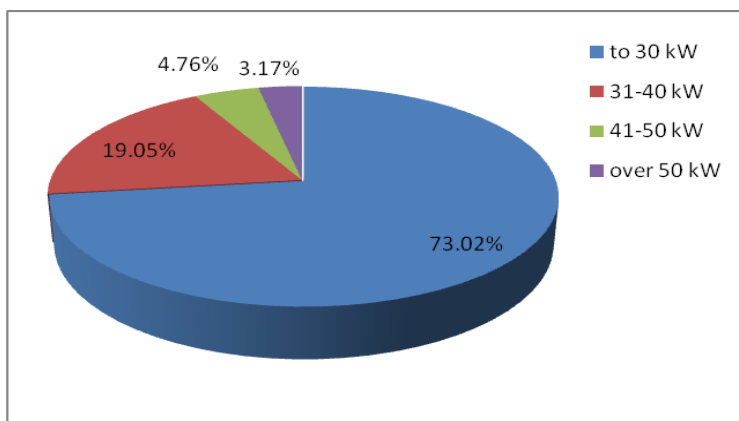


Figure 1. Two-axle tractors by category in farms

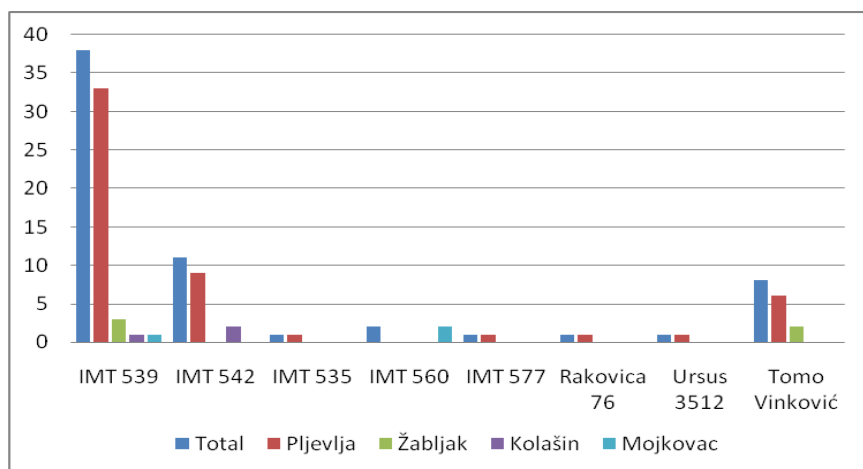


Figure 2. Tractors by types and manufacturers in the surveyed municipalities

For comparison, in Serbia there are the most tractors of 19-37 kW (61%) and 37-66 kW (31%) (Radivojević, 2014). In Poland, of the total number of tractors, 31% is engine power up to 50 kW, and the same percentage of tractors is over 50 kW (Juscinski et al. 2017). In Hungary, the number of 60 kW tractors has increased 4.5 times, but tractors up to 59 kW still predominate on farms (Kesmarki-Gally and Rak, 2017). Tractor sales in Slovenia in 2014 were the same for tractors with a power of 40-60 kW (33%) and 60-80 kW (34%) of the total number of tractors sold in that year (Poje, 2016). In Turkey, according to Bahattin et al. (2013) is a tractor engine power of 36-51 kW (37.55%) of the total number of tractors.

The Ministry of Agriculture and Rural Development of Montenegro, through EU funds, provided non-refundable funds for investments in equipping farms through projects. Approximate number of new tractors first time registred and producead in the previous and current calendar year of registration in period 2011-2019 are 818.

In the surveyed area, some farmers used these funds and procured new tractors Ursus, Belarus, Foton, Mahindra, Tafe, which were not included in the research results, because they were procured after the survey.

In addition to the number of tractors and their power, the level of mechanization also determines the number of attached machines on farms.

Table 5. Equipment with attached machines on family farms by municipalities

Municipality	Total number attached machines	Number attached machines on farms	Number ha per attached machines	Number attached machines per tractor
Pjevlja	105	1.48	9.95	2.06
Žabljak	14	0.88	20.57	2.80
Kolašin	15	0.83	9.20	5.0
Mojkovac	22	1.22	6.43	5.5
Total /Average	157	1.28	10.27	2.49

According to statistical data in Montenegro, family farms have 8196 attachments for two-axle tractors. The most have trailers 57% and tillage machines, while have less mowers 17%, presses hay 12.63%, and the least of sowing and planting machines 3.11%

The family farms covered by the research have 157 different attachments for two-axle tractors. Most plows are 23.57% and trailers 22.93% of the total number of attached machines. The tractor is mostly used for transport, and less in tillage, because only 3.59 ha of arable land is plowed with one plow. Harrows, smaller rotary cultivators, disc harrows, rollers are mostly used for pre-sowing soil preparation, and only 1 seedbed cultivator is used (Tables 5 and 6).

From the machines for harvesting fodder plants, the farmers own 18 tractor mowers, 9 hay collectors and 12 hay presses. Every other surveyed farm owns one of the mowers (motor or tractor mower).

Table 6. Number of tractor attachments by types in the surveyed area by municipalities

Type of machine	Pjevlja	Žabljak	Kolašin	Mojkovac	Total
Plow	22	3	5	7	37
Harrow	17	-	4	4	25
Roller	3	-	-	1	4
Tractor trailers	23	5	3	5	36
Disc harrows	1	1	-	1	3
Sediment spreader	3	-	-	-	3
Manure spreader	3	1	-	-	4
Haymaker	5	-	1	3	9
Tractor mowers	16	2	-	-	18
Cutter	4	-	-	-	4
Seedbed cultivator	1	-	-	-	1
Square beler	7	2	2	1	12
Total	105	14	15	22	157

In this area, farmers have an average of 1.28 tractor attachments per farm, which is close to the national average. On average, one two-axle tractor with a power of 30.12 kW cultivates 10.27 ha of available land with 2.49 attached machines. In the Northeast part of Montenegro are 2.49 machines per two-axle tractor, 2.67 in Kosovo, 5.89 in Serbia, 7.26 in Turkey (Koprivica et al. 2009, Koprivica et al. 2010, Radivojević, 2014, Ozpinar, 2020).

CONCLUSIONS

Family farms are not sufficiently equipped with two-axle tractors (0.51 tractors per farm), which is below the national average (0.87 tractors per farm). Two-axle tractors with rear and front-wheel drive (double traction) over 50 kW is generally missing. The equipment of tractors with attachments is very poor, because there are 2.49 attachments on 10.27 ha of used land per one two-axle tractor with a power of 30.11 kW. In the surveyed area, and in the whole of Montenegro, there is a lack of combined machines for rational basic tillage and pre-sowing soil preparation: chisel plows, combined machines (seedbed cultivator), medium-heavy disc harrows and rotary harrows, as well as seeders for small grains and corn. In addition, there is a lack of tractor mowers with a double cutting machine, hay collectors and tedders, self-loading trailers, forage harvesters, roll presses, wrappers and balers for silage and haylage.

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REFERENCES

- Bahattin A. (2013): Agricultural mechanization in Turkey. IERI Procedia 5 (1)41-44.
- Baranyai Z., Szabo G., Vasary M. (2014): Analysis of machine use in Hungarian agriculture - Is there any future for machinery sharing arrangements. Roczniki (Annals), Polish Association of Agricultural Economists and Agribusiness. Stowarzyszenie Ekonomistów Rolnictwa e Agrobiznesu (SERiA) vol. XVI (3) p. 24-29
- Juscinski S., Piekarski W., Chomik Z. (2017): Analysis of Power Equipment Level on the Example of Farm Tractors in Selected Farms of Przeworsk Province. Agricultural engineering, Vol. 21, No.3, pp. 17-27.
- Kesmarki-Gally S. E., Rak R. (2018): Challenges for the development of agricultural power machines and their operating costs in Hungary. Roczniki Naukowe SERiA XX (5) p. 81-86.
- Koprivica R., Veljković B., Thaqi A., Sharku A. (2010): Opremljenost porodičnih farmi poljoprivrednom mehanizacijom na području Šar Planine. Traktori i pogonske mašine, Vol. 15 No 4, p. 51-58. Novi Sad.
- Koprivica, R., Veljković B., Dedić T., Martinov, S. (2009.): Analiza obezbeđenosti traktorima na porodičnim gazdinstvima u području Severoistočne Crne Gore. Traktori i pogonske mašine, Vol. 14, No 5, p. 23-28, Novi Sad.
- Ozpinar, S. (2020): Mechanization and agricultural farm structure in the agricultural area of the Dardanelles region. Int. J. Agric. Environ. Food Sci., 4(1), 39-56.
- Perošević, N. (2020): Agriculture development in the Municipality of Nikšić (1945-1991). Agriculture and Forestry, 66 (1): 83-94.
- Poje T. (2016): Stanje traktorske tehnike na Slovenskim obiteljskim gospodarstvima. 51.Hrvatski i 11. međunarodni simpozij agronoma, 15.-18. veljače 2016. godine, Opatija, Hrvatska, Zbornik radova 2016 pp.498-501.
- Radivojević D. (2014). Poljoprivredna mehanizacija oprema i objekti, ISBN 978-86-6161-111-7, COBISS.SR-ID 206984204 CIP 631.3 (497.11) "2012" (083.41), Zavod za statistiku Republike Srbije, Posebna publikacija - Monografska studija p.p. 1-154.
- Statistical Office of Montenegro (2011): Structure of agricultural holdings Agricultural census 2010. Podgorica
- Statistical Office of Montenegro (2019): Annual statistics of transport, storage and communications
[https://www.monstat.org/userfiles/file/saobracaj/2019/PUBLIKACIJA-%20GODISNJA%20STATISTIKA%20SAOBRACAJA%202019-cg\(1\).pdf](https://www.monstat.org/userfiles/file/saobracaj/2019/PUBLIKACIJA-%20GODISNJA%20STATISTIKA%20SAOBRACAJA%202019-cg(1).pdf)
- Šarović R. (2014): Agricultural family farm in Montenegro. Agriculture & Forestry, Vol. 60. Issue 1: 145-156.
- Veljković B., Koprivica R., Milošević T., Radivojević D., Bročić Z. (2020): Udruživanje u funkciji održivog ruralnog razvoja. Agroekonomika godina 49 br. 86 p. 1-11.
- Zimmer D. (2019): Optimalno opremanje poljoprivrednih gospodarstava sredstvima poljoprivredne mehanizacije. Doktorska disertacija. Fakultet agrobiotehničkih znanosti Osijek Sveučilište Josipa Jurja Strossmayera u Osijeku.