



Evaluating Environmentally Sustainable Production Practices in Rural Areas

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Abstract: Forests and forestry are the ecological and economic infrastructure of every state. The EU strategy for the forest-based sector is particularly related to rural development, since, in such areas, forests are mostly spread, thus representing an opportunity for more balanced development, or in other words - survival of rural areas. Croatia is no exemption. The goal of forest management in the Republic of Croatia is the sustainable and harmonious use of all forest functions and the permanent improvement of their condition, by promoting environmentally sustainable production practices in such a way that the local or rural environment has financial benefits. Looking at forests as perfect factories, ranging from the production of wood pulp as raw materials, oxygen and food, water purifiers, carbon tanks and all the way to the intangible and generally useful functions of forests, it is necessary to observe their all-encompassing importance. We are facing global climate change, which significantly influences the restoration and erection of new forest stands, that is one of the most important procedures for sustainable forest management in Croatia. Current techniques and knowledge that are being applied contribute to discouraging results, therefore it is crucial to introduce and promote new environmentally friendly practices, aiming to increase the productive function of forest land and forest as an ecosystem. In accordance with the sustainable development of forest land, research was conducted in the lowland part of Sisak-Moslavina County in Croatia. The aim of the research is to study the cost-effectiveness and compare the adaptation of new methods and practices of reforestation, with the end result of the forested area as a production unit, and that was conducted working on two land sections. On the surface of the first section, which was previously chemically prepared, a classic renovation was performed by sowing acorns employing a spreader. The acorn was collected by the local population. Processing of the second section included planting seedlings, while the section was previously mechanically prepared by grinding biomass and an integral method of soil preparation in rows with a spacing of 3 m. The internal planting distance between the plants was 0.80 - 1.0 m, and work was carried out with the help of external contractors, the local population. The use of new environmentally sustainable technologies has resulted in 29% higher financial costs of forestation. However, using new practices compared to the classical ones, the financial viability in terms of economic profit of the rural area was determined. The application of new silvicultural practices is initially more expensive, but results in a shorter period of time to achieve targeted results, while the increase in costs refers to the involvement of the local community that participated in the works.



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1. INTRODUCTION

Rural territories in Croatia are those areas in which bioeconomic (forestry and agriculture) activities economically predominate, with a key role in the management of rural resources. About 90% of the total Croatian territory is a rural territory where approximately 40% of

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the total Croatian population lives. Forestry and agriculture are the main users of rural areas, which in Croatia lag significantly behind in development in relation to industrially urbanized centers and regions. There are many sources of development disparities between urban and rural regions. Croatian rural area has been facing processes of de-agrarization and depopulation for decades. At the global level, economic theories of polarized development are common, which explain the emergence and maintenance of regional and national differences in development. Although inequalities in development are also known in the pre-industrial period, it is the industrialization and tertiarization of the economy that led to great differences between the village and the city. Theories of polarized development developed in the 1950s (Mataga, 2003) show that the industry, due to its many advantages, develops more strongly those cities and regions in which it is located, while other areas, especially rural areas, lag behind. The initial advantage is increasing over time as the industrial sector attracts labor and results in increase in urban population, infrastructure development, capital attraction and tertiary sector development. Accordingly, a multiplication effect and an increase in the initial advantages are obvious, thus boosting differences in space.

According to the Statistical Office, the Croatian sector based on the bioeconomy employs more than 115,000 people, while the forestry and wood processing industry alone employs about 53,000 people, with revenues of almost EUR 2 billion per year (Posavec, 2020). In the context of rural development, forestry, in addition to the general welfare of the environment, carries the role of employment, as well as the use of non-timber forest products (NTFP) and wood raw material by the local population - although their use is multiple, they are incomparably less used for commercial purposes (Vuletić et al. 2011).

The total area of forests and forest lands in Croatia is 2,759,039 ha, which is 49.3% of the country's land area. According to available data, 24% of forests are owned by private forest owners while 76% are owned by the Republic of Croatia. The majority of 97% of state forests are managed by the public forest owner Croatian Forests LLC, while the remaining 3% is used by state administration bodies or legal entities founded by the Republic of Croatia. A wood stock of 418,618,277 m³ has been determined in the forest management area, and in state forests managed by Croatian Forests LLC it amounts to 319,013,300 m³. The most common species is the common beech (*Fagus sylvatica* L.) with 38%, while our most valued and most valuable tree species - pedunculate oak (*Quercus robur* L.) is represented by a 14% share in the total wood stock (Janeš, 2021). Croatia is recognizable by its pedunculate oak forests, which are a rarity on a European scale. Pedunculate oak forests grow on 215 thousand hectares, in the valleys of the Sava, Drava and Danube rivers. The management of these forests is characterized by a long patrol of 140 years, intensive care from the earliest stages of development and restoration by seed cutting. The restoration of forest stands, especially pedunculate oak, is a significant issue. Climate change on a global scale is nothing new. One of the two most endangered territories by recent climate changes which are marked by an overall increase in temperature and a significant change in the precipitation regime is the area of Southeast Europe. According to the results and forecasts of the Nature CC study (Griscom B.W. et al., 2017), we will face catastrophic deforestation, and by 2030 deforestation will increase due to hailstorms, fires and droughts in the amount of + 0.91 x 10m³. According to research by Hanewinkel et al., from 2013 to 2100, we will lose 14-50% (28%) of the value of forests, which amounts to several trillion euros (Hanewinkel, et al. 2013). Specifically, due to the longer water retention during spring and summer, the seeds decay and especially the sinkholes and young shoots in the stands in the regeneration process, and even in areas where the initial phase of regeneration is completed. Extreme rainfall leaves

behind long-term consequences because it physiologically weakens the forest and destroys the forest infrastructure, which makes rehabilitation difficult. The physiologically weakened forest is the target of forest pests whose attacks are regularly followed by infections. In floodplain lowland ecosystems, the main natural disaster is drought, which is the main trigger for the penetration of harmful insects and fungal diseases. But in addition to drought, excessive flood water retention, especially in the summer months, can significantly impair the vitality of species, especially the oak. Climate change has affected the emergence and increase in the number of many invasive insect species in our forests. Of all the invasive organisms, 2/3 are insects such as the oak bed bug, due to which the oak canopies are already intensely brown in the middle of summer. Increased air temperature, changes in the amount and distribution of precipitation, frequent and intense storms, prolonged, intense and frequent droughts, changes in flood length, vegetation period and lack of soil freezing are just some of the direct climate changes. Climate has a complex interaction of natural processes with forests, while forest management is becoming more complex due to new social circumstances. Forests are also exposed to additional pressures due to increased human activity. The non-profit functions of forests are becoming increasingly important to man, while society's demands for products and services from our forests are continuously growing.

A legitimate concern stems from the fact that habitat is changing and threats are growing far faster than the ability of our species to adapt to emerging conditions. In addition, new threats to forests are constantly emerging, about which we do not yet have sufficient knowledge. All of the above is the cause of significant biological and financial losses, large expenditures on rehabilitation and reconstruction, and the need to find new and quick solutions. According to Andreas Bolte, PhD, one of the greatest experts in the field of silviculture, our activities are becoming more complex and expensive, and direct losses are higher (Bolte, 2019.) It is crucial to carry out adaptive silvicultural activities. Unfortunately, today's silvicultural activities have the character of interventions in which it is necessary to find a quick and effective solution to increasingly complex problems in the field. Modern forestry should be based on identifying already present and future threats, making predictions of future habitat conditions, the reaction of species to them, the degree to which individual species can adapt and the shift in their distribution. This is the basis for both components of forest adaptation, which ultimately aim to establish more resilient and plastic forests. The first component is focused towards the restoration of surfaces that are under increasing negative influences at the most sensitive stage of development. The second component emphasizes risk assessment, selection of species and provenances that will be more resistant to anticipated threats (substitution of existing species), patch length adjustments, thinning adjustments, habitat preparation methods, fire prevention, breeding interventions, etc. (Đodan, 2019).

Fully aware of the described situation, we are obliged to ensure the general stability of forests, as well as the durability of revenues and public utility functions. Since its initiation, forestry has relied on the naturalness of conditions and the adaptation of species and provenances to specific habitat conditions. However, how to sustainably manage forests when habitat conditions are in rapid change, far faster than patrolling our economically important tree species? The aim of this paper is to evaluate the success of introducing new methods on forest land production areas in order to ultimately get better, more stable and more valuable forest systems - production of wood and non-wood forest products, while the local rural community has economic benefits. This can be achieved by reducing impending losses and maintaining the sustainability of our forests. The application of methods and practices such as integrated soil preparation and the

new planting principle is one of the possible responses to the challenges of climate change, the emergence of new pests and faster achievement of the ultimate goal faced by both private forest owners and state-owned forest managers. Studies investigating the effectiveness of different restoration strategies are scarce, especially long-term analysis (García et al., 2020). This research aims to fill the gap regarding different forest restoration approaches that can be considered environmentally sustainable production practices.

2. MATERIAL AND METHODS

The research was conducted in the lowland part of Sisak-Moslavina County, in commercial forests, economic units of “Popovačka lowland forest”, sections 14a and 54c. Commercial forest section 14a is an integral part of the economic unit “Popovačka lowland forest” which is managed by Šumarija Popovača and covers an area of 16.41 ha. According to the forest management program, pedunculate oak is growing from seed, meaning that the realization of raising a new forest stand in practice was done by the method of natural regeneration under a curtain (sowing seeds). Natural rejuvenation of one-time forest stands is based on several cuts of the main income by which the old stand is replaced by a young one, and it is a preparatory, fertile, if a subsequent and final cut is needed. The first cut starts in the year of good harvest, and the final when there is a satisfactory number of plants, which have strengthened enough for independent growth and development. This provides a place for the young stand to continue its path to economic maturity and then the process is repeated. This procedure is called patrol, and for pedunculate oak it takes approximately 140 years. With gradual cuttings, we receive the acorn reception area, while there are parent trees that should give offspring, and all undesirable species (weed vegetation) that reduce the possibility of receiving the desired seed are removed. In addition to the expected yield of parent trees, additional collected seeds from other areas are also spread. Natural restoration began in 2016, by fencing the surface with a 1.22 km fence of reinforcing mesh to prevent the wildlife entry that could destroy the seed. The fertile cutting opened the inflow of light to the ground and allowed the parent trees a larger assimilation area in order to better produce seeds - acorns. Moreover, in October of 2016, additional acorns were purchased from the local population (16,410 kg) and sown with a machine spreader. In 2017, the area was additionally opened by subsequent cutting. Chemical care of not yet germinated seeds from 2016. was conducted in the first week of April 2017. The procedure is justified, because weed vegetation that leaves before the oak was removed, which is of course more cost-effective than mechanical preparation (Table 1). In mid-May 2017, control was carried out against plant diseases, in this case against powdery mildew in order to preserve the newly germinated plants, formed partly from the mother trees of the old stand, and partly from scattered acorns. The walkway counted 21 young oaks, on a sample area of 10x10m (100m²). Further counting showed that the number dropped drastically due to the extremely dry period during July and August, and only one young oak was counted at the end of September. In the autumn, the area of 13.60 hectares was treated with a total herbicide. The treatment area was reduced due to the lowland filled with water as a result of autumn rains. However, due to poor yields and subsequently poor purchase, only 620 kg of acorns of the planned 16,410 kg were scattered by the spreader. The yield of the parent trees was completely absent. Forest monitoring of the exemplary plot during 2018 found only 2 oaks as a result of acorns scattered in 2017. The planned chemical preparation with total herbicide was carried out again on the entire surface of section 14a in the fall of 2018 in order to destroy the new weed vegetation and prepare the surface for acorns. The acorn yield was satisfying, so we scattered 16,410 kg with a spreader by the end of October 2018. Monitoring the area in April 2019, the count again ended in poor results, with only 5 plants on the sample plot.



Picture 1. Section 14a – receipt of germinated plants in 2020

This was followed by a repeated chemical preparation with a total herbicide on the entire surface of the department during October 2019. in order to destroy weed vegetation and prepare the area for receiving acorns, and soon a new 12,616 kg of acorns were sown with a spreader, due to a lower yield than expected. By visiting during 2020, on three occasions (May, July, September) and by counting, a satisfactory number of 26 young oaks was established on the sample plot (Picture 1).

Commercial forest 54c section is an integral part of the economic unit “Popovačka lowland forest” with an area of 15.83 ha, and according to the forest management program it predominately consists of domestic poplar mixed with pedunculate oak and individual maple, elm and acacia trees. The realization of raising a new forest stand in practice was done by the method of direct conversions planting. (Benko, 2020.) Conversion (lat. *Coversio* - conversion) is a breeding procedure by which the conversion, or in other words translation of one breeding form into another, is performed by applying appropriate breeding measures. Direct conversion is performed by sowing or planting the same or other economically valuable species of forest trees, when the biological potential of the forest does not ensure the success of certain cultivation or economic measures in creating the preconditions for natural regeneration (Dubravac, et al. 2001). The aforementioned 54c section was fenced by a braid in the length of 0.87 km. Knitting was chosen because the renewal is done by planting seedlings, and there is no fear of destroying planting material from the game – that is the advantage of using seedlings, which allows for significant savings. During January and February 2020, mechanical soil preparation was performed, that shredded all biomass left after the main harvest was cut, and the soil was immediately loosened with a milling machine. Integral soil preparation has many benefits since, in addition to shredding compacted soil, it mixes biomaterial from the surface into the area of root growth, and also retains the required moisture during the dry period. By the beginning of April, 110,810 pedunculate oak seedlings were planted in rows spaced 3 meters apart (Picture 2).

The distance between the seedlings was set at 0.80-1.0 m within the row. The seedlings were 2 years old and brought from the Lukavec nursery, grown and nurtured with visible better height gain than those plants that we expect in the second year of development, and obtained by sowing

acorns. In May 2020, the control of plant diseases was carried out - against powdery mildew. By counting the received seedlings during September, the receipt of 87% was established (31 seedlings). At the end of April 2021, the monitoring was performed again on the same plot, and an identical number of survivals of planted seedlings was established.



Picture 2. Section 54c - receipt of pedunculate oak seedlings

For most of our analysis, we used data available from two sources. The first is HsPPU, a specialized tool for monitoring, analyzing, and costing forestry methods. Furthermore, the chronology of works was taken from the management program for the economic unit “Popovačka lowland forest” and the internal documentation of Croatian Forest LLC. Data processing was performed using MS Excel.

3. RESULTS AND DISCUSSION

The success of reforestation by classical sowing in the years when acorn yields were not lacking was barely noticeable; the number of plants decreased every year due to abiotic and biotic factors (Figure 1), despite regular care and monitoring measures, creating financial losses.

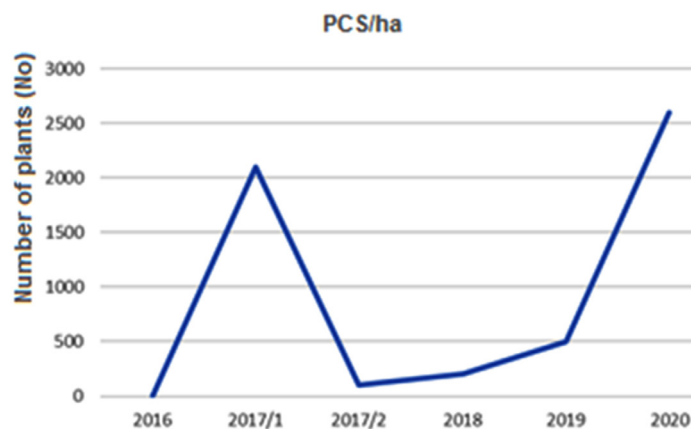


Figure 1. Fluctuation of abundance and survival of young plants derived from seeds

A satisfactory abundance resulted only when the positive factors coincided. The described data indicate that investment was required in the period 2016-2020 year to achieve the end result (Table 1), for these plants to be stable enough to continue their growth and development, subject to the implementation of future care procedures, and depending on their course of development. The costs of repeated habitat preparation and sowing amounted to for the monitored period 2016-2020 a total of HRK 480,270, or HRK 29,266.91 per hectare. The income of the local population collecting acorns depended on the harvest, which was absent or reduced in some years. Acorn collection is not standardized and is often reduced to several large buyers in the territory of the Republic of Croatia, with no necessity to establish an employment relationship.

Table 1. 14a section - HsPPU data analysis

Year of execution	Name of work	Section	UMW (JMR)	Amount	STANDARDS AND COSTS (materials, work, services)								general cost correction
					Cost elements	Type of performer	Vli	UCM (JMT)	UCM/UMW	Qty-UCM	Price	Total HRK	
2016.	Sowing oak acorns	14a	ha	16,41	Pedunculate oak - seeds	I		kg	1000,000	1641	5,00	82050	
					Tools and equipment	I		HRK	1,0000	16,41	3,75	61	
					Seed transport	pt 41-60+unit	V	COB -sd	0,1000	1,64	1304,00	2138	
					Work -Spreader	pt 41-60+spreader uni	V	COB -sd	0,3380	5,55	1542,00	6558	
					Work -worker	Work-other jobs	V	COB -nd	1,0000	16,41	559,98	9189	
												101997,00	76497,75
2016.	Raising the reinforcement fence	14a	km	1,22	Iron nails type "U"	I		kg	20,0000	24,4	19,00	463	
					Wire 3mm	I		kg	50,0000	61	6,00	366	
					Reinforced mesh 4x2	I		PCS	260,0000	317,2	93,00	29499	
					Wooden pillars 80x80x3000mm	I		PCS	260,0000	317,2	30,00	9516	
					Transport of material	pt 41-60+unit	V	COB -sd	1,0000	1,22	1304,00	1590	
					Material supply	dump truck	U	COB -sd	1,0000	1,22	2498,00	3047	
					Work -worker	Work-entrepreneur	R	COB -nd	27,0000	32,94	308,88	10174	
												54658,00	40993,50
2017.	Preparation chemically sprayer	14a	ha	16,41	Herbicide tot.glif	I		L	5,0000	82,05	50,00	4102	
					Water transport	pt 41-60+unit	V	COB -sd	0,0555	0,91	1276,00	1161	
					Work- sprayer	pt 41-60+sprayer uni	V	COB -sd	0,1666	2,73	1079,00	2945	2461,5
					Work -worker	work - chemical agei	V	COB -nd	0,1666	2,73	599,83	1637	
												9846,00	7384,50
2017.	Preparation chemically sprayer	14a	ha	13,60	Herbicide tot.glif	I		L	10,0000	136	50,00	6800	
					Water transport	pt 41-60+unit	V	COB -sd	0,0555	0,75	1276,00	957	
					Work- sprayer	pt 41-60+sprayer uni	V	COB -sd	0,1666	2,27	1079,00	2449	
					Work -worker	work - chemical agei	V	COB -nd	0,1666	2,27	599,83	1361	
												11567,00	8675,25
2017.	Chemical protection sprayer	14a	ha	16,41	Fungicide	I		L	5,0000	5,76	320,00	1843	
					Tools and equipment	I		HRK	0,1666	1,92	3,75	7	
					Water transport	pt 41-60+unit	V	COB -sd	0,0555	0,64	1276,00	816	
					Work- sprayer	pt 41-60+sprayer uni	V	COB -sd	0,1666	1,92	1079,00	2071	
					Work -worker	work - chemical agei	V	COB -nd	0,1666	1,92	599,83	1151	
												5890,00	4417,50
2017.	Sowing oak acorns	14a	ha	0,62	Pedunculate oak - seeds	I		kg	1000,000	1641	8,00	4960	
					Tools and equipment	I		HRK	1,0000	16,41	3,75	2	
					Seed transport	pt 41-60+unit	V	COB -sd	0,1000	1,64	1276,00	76	
					Work -Spreader	pt 41-60+spreader uni	V	COB -sd	0,3380	5,55	1514,00	317	
					Work -worker	Work-other jobs	V	COB -nd	1,0000	16,41	549,22	340	
												5697,00	4272,75
2018.	Preparation chemically sprayer	14a	ha	16,41	Herbicide tot.glif	I		L	8,0000	131,28	50,00	6564	
					Tools and equipment	I		HRK	0,1666	2,73	3,75	10	
					Water transport	pt 41-60+unit	V	COB -sd	0,0555	0,91	1238,00	1126	
					Work- sprayer	pt 41-60+sprayer uni	V	COB -sd	0,1666	2,73	1049,00	2863	
					Work -worker	work - chemical agei	V	COB -nd	0,1666	2,73	569,64	1555	
												12119,00	9089,25
2018.	Sowing oak acorns	14a	ha	16,41	Pedunculate oak - seeds	I		kg	820,000	13456,20	9,00	121105	
					Seed transport	pt 41-60+unit	V	COB -sd	0,0820	1,35	1238,00	1671	
					Work -Spreader	pt 41-60+spreader uni	V	COB -sd	0,2772	4,55	1484,00	6752	
												129529,00	97146,75
2019.	Preparation chemically sprayer	14a	ha	15,77	Herbicide tot.glif	I		L	8,0000	126,16	50,00	6308	
					Tools and equipment	I		HRK	0,1666	2,63	3,75	9	
					Water transport	pt 41-60+unit	V	COB -sd	0,0555	0,88	1311,00	1153	
					Work- sprayer	pt 41-60+sprayer uni	V	COB -sd	0,1666	2,63	1122,00	2950	
					Work -worker	work - chemical agei	V	COB -nd	0,1666	2,63	610,79	1606	
												12028,00	9021,00
2019.	Sowing oak acorns	14a	ha	15,77	Pedunculate oak - seeds	I		kg	800,0000	12616,00	9,00	113544	
					Tools and equipment	I		HRK	0,8000	12,62	3,75	47	
					Seed transport	pt 41-60+unit	V	COB -sd	0,0800	1,26	1311,00	1651	
					Work -Spreader	pt 41-60+spreader uni	V	COB -sd	0,2704	4,26	1557,00	6632	
					Work -worker	Work-other jobs	V	COB -nd	0,8000	12,62	561,90	7091	
												128967,00	96725,25
2020.	Chemical protection sprayer	14a	ha	15,77	Fungicide	I		L	0,7000	11,04	316,50	3494	
					Water transport	pt 41-60+unit	P	COB -sd	0,0555	0,88	1332,00	1172	
					Work- sprayer	pt 41-60+sprayer uni	P	COB -sd	0,1666	2,63	1143,00	3006	
					Work -worker	Work-entrepreneur	R	COB -nd	0,0500	0,79	380,00	300	
												7972,00	5979,00
												480270,00	360202,50
												Total	

By applying new adaptive cultivation methods and practices, a better result is observed in the area where the integrated method of soil preparation is by loosening or milling, planting seedlings in rows, and the work of the local population in rural areas. The prescribed daily output is 161 planted plants, which means that 688 workers/day were needed to plant 54c sections. As planting is done during the dormancy of vegetation, without snow cover and daily temperatures below zero, a large number of people are needed to plant the said area. The results of the costs of raising forests by planting seedlings using new methods amount to 42,610.17 Kn / ha (Table 2), and in comparison, they are 28.79% higher per hectare of forest than previous classic forest restoration.

Table 2. 54c section - HsPPU data analysis

Year of execution	Name of work	Section	UMW (JMR)	Amount	STANDARDS AND COSTS (materials, work, services)								general cost correction	
					Cost elements	Type of performer	Vli	UCM (JMT)	UCM/UMW	Qty-UCM	Price	Total HRK		
2020.	Removal of ground vegetation	54c	ha	15,83	Work -soil rotator	pt 41-60+rotator	P	COB -sd	0,5920	9,37	1332,00	12480,00		
					Work -chopper mach	pt 90+sit./2,25	P	COB -sd	1,2500	19,79	2441,00	48307,00		
					Work -chainsaw	Work-entrepreneur	R	COB -nd	2,0000	31,66	380,00	12030,00		
												72819,00	54614,25	
2020.	Soil milling (conv.)	54c	ha	3,96	Work -milling machir	pt 41-60+unit	U	COB -sd	1,3334	5,28	1332,00	7032,00		
												7032,00	5274,00	
2020.	Planting deciduous seedlings	54c	ha	15,83	Pedunculate oak -2+0 30-120		U	PCS	7000,0000	110810,00	4,00	340294,00		
					Tools and equipment		I	HRK	43,4000	104,16	3,75	390,00		
					Transport of seedling	pt 41-60+priklijućak	U	COB -sd	0,8750	1,26	1332,00	18460,00		
					Work -worker	Work- using hand to	V	COB -nd	43,4000	104,16	583,35	60761,00		
					Work -worker	Work-entrepreneur	R	COB -sd	26,7750	4,26	430,00	136381,00		
												556286,00	417214,50	
2020.	Chemical protection sprayer	54c	ha	15,83	Fungicide		I	L	0,7000	11,08	370,00	4099,00		
					Water transport	pt 41-60+unit	P	COB -sd	0,0555	0,88	1332,00	1172,00		
					Work- sprayer	pt 41-60+sprayer uni	P	COB -sd	0,1666	2,64	1143,00	3017,00		
					Work -worker	Work-entrepreneur	R	COB -nd	0,0500	0,79	380,00	300,00		
												8589,00	6441,75	
2020.	Raising a wire fence	54c	km	0,87	Iron nails type "U"		I	kg	36,0000	31,32	19,00	595,00		
					Iron nails - larger		I	kg	26,0000	22,62	10,00	226,00		
					Wire type "celeia"		I	m2	1000,0000	870,00	4,72	4106,00		
					Wire type 5mm		I	kg	850,0000	739,5	10,00	7395,00		
					Tying wire 1mm		I	kg	70,0000	60,90	6,00	365,00		
					Wooden pillars		I	m3	25,0000	21,75	200,00	4350,00		
					Transport of material	pt 41-60+unit	V	COB -sd	5,0000	4,35	1332,00	5794,00		
					Drilling works	pt 61-90+drill unit sn	P	COB -sd	0,8800	0,77	1683,00	1295,00		
					Work -worker	Work-entrepreneur	R	COB -nd	17,1400	14,91	380,00	5665,00		
												29793,00	22344,75	
												Total	674519,00	505889,25

The main advantage of the new method is the independence from the current year's acorn yield. This is supported by the fact that in 2020 the number of acorns managed to be purchased was slightly higher than the need for nursery production, which grows it in controlled conditions without major deviations. Due to their age, associated with height gain, seedlings are out of reach of greater damage by wildlife. Older plants are more resistant to abiotic and biotic negative factors. Planting material is from reliable sources. Unlike seeds, seedlings are easier to store in case of bad weather or delayed work. The end result was achieved in one year, which means that the time and resources obtained can be redirected to other works and areas.

The long and complex process of natural regeneration can be accelerated by intensive silvicultural procedures. New methods of habitat preparation for forest raising, planting, selection and distribution of forest species accelerate the emergence of young plants from the zone of weed vegetation. The introduction of new technologies and approaches to the forestry profession also ensures greater resistance to negative biotic and abiotic factors. Company investments in the form of Grants (measure M08, Investments in forest development and improvement of forest sustainability, Sub-measure 8.5 Support for investments in improving the resilience and environmental value of forest ecosystems, Type of operation 8.5.1. Conversion of degraded forest stands and forest culture), returns as a kind of decentralization and survival of rural areas. The limitations of the research can be seen in the fact that the research was conducted exclusively on the example of pedunculate oak, although the new methods can be replicated in all major economic tree species, limited only by nature's features due to the use of mechanization.

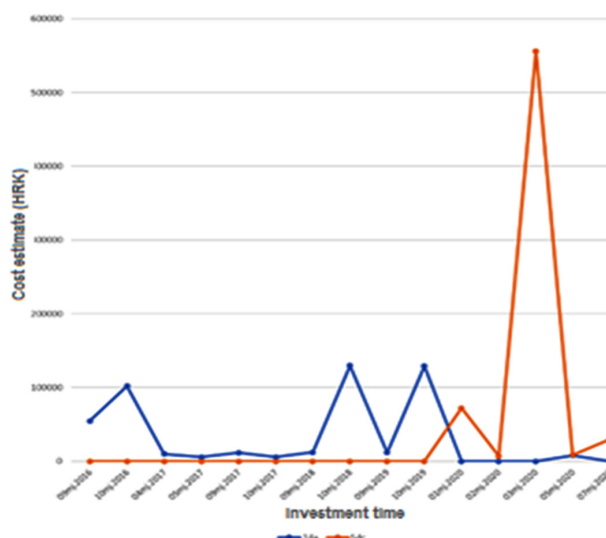


Figure 2. Investment trend to overgrown area

4. CONCLUSION

Today, the forests and forestry of Croatia are facing new challenges. The importance of sustainable forest management takes on new dimensions of preserving the forest ecosystem in its original form and ensures the sustainability of income. The results of the research indicate that the use of new methods of forest regeneration creates 29% higher costs, but the time to the final goal of achieving a satisfactorily rejuvenated forest area is even four times shorter. At the same time, a much larger local population is employed alongside forest workers - observing only planting works that require 43 workers/day per hectare; an economically positive effect on rural areas is obvious. Therefore, supporting the new EU strategy for forests and the forest-based sector, especially in relation to rural development, is an opportunity for a more balanced development of the Republic of Croatia, i.e. the survival of rural areas. Forest should be managed in a multidisciplinary and sustainable way, using all the potentials of space and new technologies. Considering the areas of unforested forest lands and degraded forests that are available, the possibilities of afforestation and revitalization are open. This would contribute to employment and the return of life to rural areas, the improvement of living conditions, the general beneficial and economic effects of forests. Therefore, investments in forests and forestry should be viewed in the context of state development, especially rural areas where forest lands dominate.

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